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THE WORLD IS ITS FIELD

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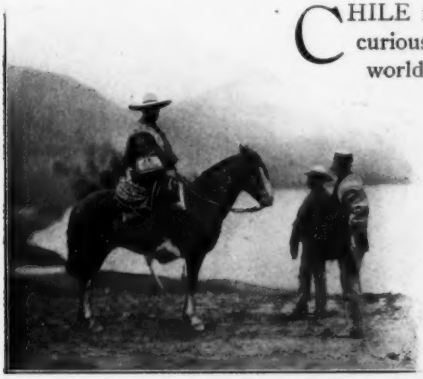
THE INDUSTRIAL FUTURE OF CHILE IN CONNECTION WITH THE PANAMA CANAL.

By G. Fred. Collins.

For many of the statistics in the following article I am indebted to my old friend J. Parker Read, Esq., the pioneer salesman and probably the largest introducer of American goods in Chile.—G. F. C.



A COUNTRY GENTLEMAN OF CHILE.

CHILE is probably one of the most curiously shaped countries in the world. Stretching as she does a distance of about 3,000 miles along the Pacific coast of South America, she will receive more benefits by the opening of the Panama Canal than any other country of South America; for with her numerous seaports and extensive coast line, and nearly 1,000 miles of navigable rivers and lakes, with a mean territorial width of only 100 miles, one can readily see how dependent her commerce must be upon the sea.

The northern extremity of the country is at latitude 17° 57′ south, and Chilean boundaries extend to the southern extremity of the Continent, mainly between the Andes and the Pacific ocean. The total area is 267,000 miles. She already has a navy of more than forty vessels and an auxiliary passenger fleet of twenty-six steamers.

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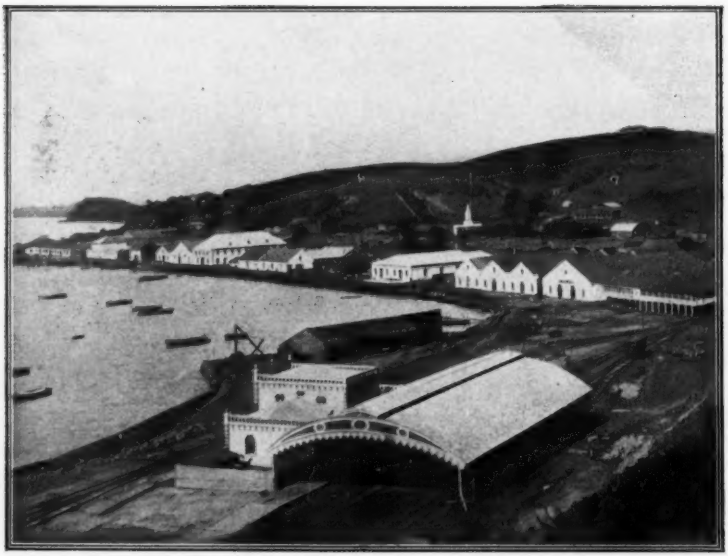
In the accompanying map, the Cordilleras are not shown, as they would confuse the reading. The international boundary, shown by a broken line, follows the crest of the Andes.

Chile is a very rich and powerful country, considering her area and her population of between three and four million people. The opening of the Panama Canal will bring her more than 4,000 miles nearer to the markets of the United States and Europe. Her foreign commerce approximates about $300,000,000 annually, and requires about 8,000 vessels with shipping capacity of over 10,000,000 tons. Her exports exceed her imports by about $40,000,000, and the merchant marine of Chile numbers nearly 200 vessels

THE ISLAND OF JUAN FERNANDEZ. THE SOLITARY LIFE OF ALEXANDER SELKIRK ON THIS ISLAND SUPPLIED THE BASIS OF THE STORY OF ROBINSON CRUSOE.
Belonging to Chile, and 400 miles off the Chilean coast.

with a carrying capacity of 100,000 tons. Her passenger steamers, which travel the west coast from Valparaiso to Panama, are amongst the finest coastwise vessels in the world, and when the canal is completed we may expect to see the proud flag of Chile in northern harbors daily.

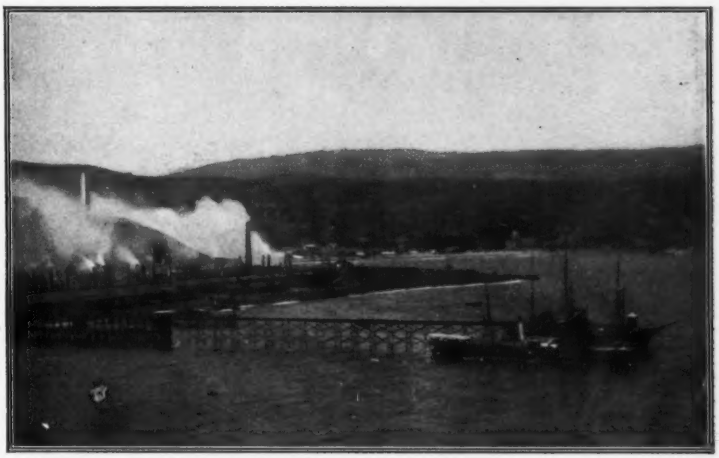
IQUIQUE, ONE OF THE PRINCIPAL NITRATE PORTS.



TALCAHUANO. FORMERLY A PORT OF CALL FOR WHALERS. PROMINENT IN THE MILITARY HISTORY OF CHILE. NOW THE SITE OF A NAVAL SCHOOL.

CORONEL. SHIPPING PORT FOR THE COAL FROM THE LOTA MINES.

The naval and military institutions of Chile are of the highest character, and the country has always maintained a formal army and navy. Today they have the discipline and armament of the most advanced nations. The military school is in Santiago, and the naval academy in Valparaiso. Cadets are instructed on the training ship General Baquedano, after which the midshipmen are sent to other parts of the world to complete their learning. There are also special schools in Valparaiso and Talcahuano, which latter in olden times was the port for whalers.



THE HARBOR OF LOTA, IN THE SOUTH OF CHILE, A COAL-SHIPPING PORT AND THE SITE OF COPPER SMELTERS.

The State railways in present operation extend more than 1,500 miles and are valued at over $100,000,000. These, together with the private railways, give the republic more than 3,000 miles of railroad. The State railways transport annually more than 7,000,000 passengers and over 3,000,000 tons of freight. In Santiago, which is the capital of the country, there are more than 60 miles of electric tramway. The Chilean post offices handle 50,000,000 pieces annually, and the postal money-order department more than $10,000,000. There are 15,000 miles of telegraph and telephones connecting all the principal towns in the republic.

The famous coal mines of Lota and Coronel have an annual yield of 1,000,000 tons and employ some 9,000 laborers. This not only supplies all Chile's needs, but also coals nearly all the European steamers entering her harbors. The coal is what is termed "soft,"

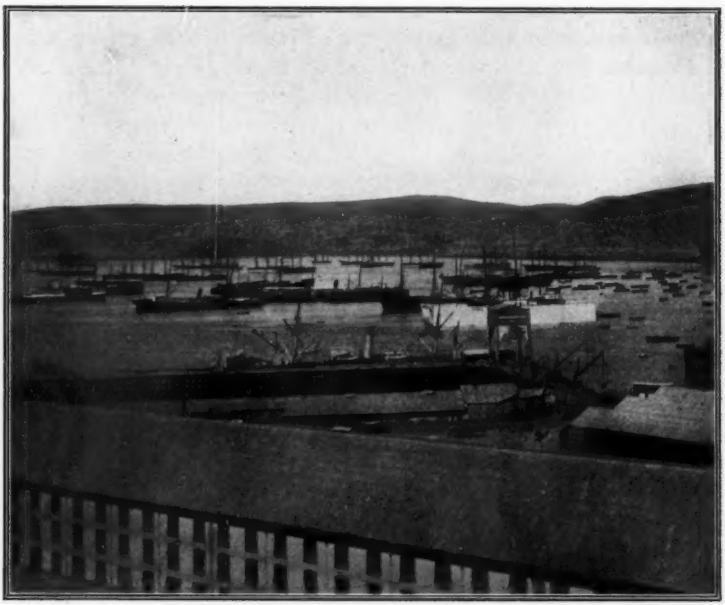
THE UPPER PICTURE SHOWS TOCOPILLA, ONE OF THE IMPORTANT NITRATE PORTS OF NORTHERN CHILE, AND THE LOWER COQUIMBO, NOTED FOR ITS COPPER MINES.

but it is of good quality. The country imports some hard coal. The most important mineral industry is of course the nitrate of soda. Chile at present has over one hundred nitrate works. The crude material (called *caliche*), is found under a conglomerate, in beds varying from a few inches to 12 feet in thickness. The process of extraction is one of leaching and refining by crystallization. About 1,400,000 metric tons of 2,204 pounds each are annually produced, estimated to be worth $54,000,000 in Europe. About four-fifths of all the nitrate exported goes to England and the Continent, Great

AVENIDA ERRÁZURIZ—THE QUAYS AT VALPARAISO.

Britain alone taking one-third and Germany a little less. A large amount of British capital is invested in the nitrate fields, sixteen of the larger companies alone representing a capitalization of more than £8,000,000. The Chilean government exact a duty of $11.52 a ton on all nitrate exported. I learn that an enormous deposit of nitrate has just been discovered in the Sahara desert. This is advance information and very important.

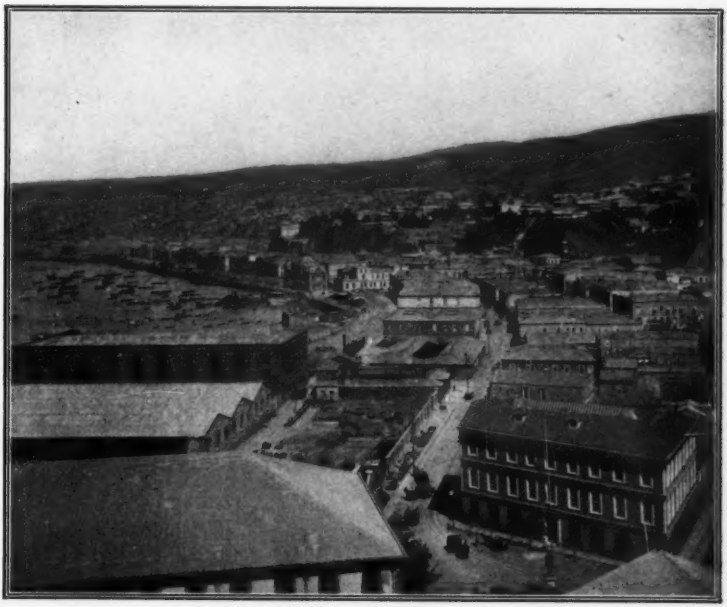
In metal mining, copper comes first both as to present output and further opportunity. The country needs modern metallurgical



VALPARAISO. THE LEADING SEAPORT OF CHILE.

processes and knowledge of successful methods for handling low-grade ores. The present production is about 30,000 tons of copper annually. Manganese is also an important industry. Silver, once very highly profitable, has declined; 74,000 kilogrammes of silver were exported in 1900. Promising gold deposits exist, especially in southern Chile. $30,000,000 in gold, gold ores, and matte, have been exported in the past ten years.

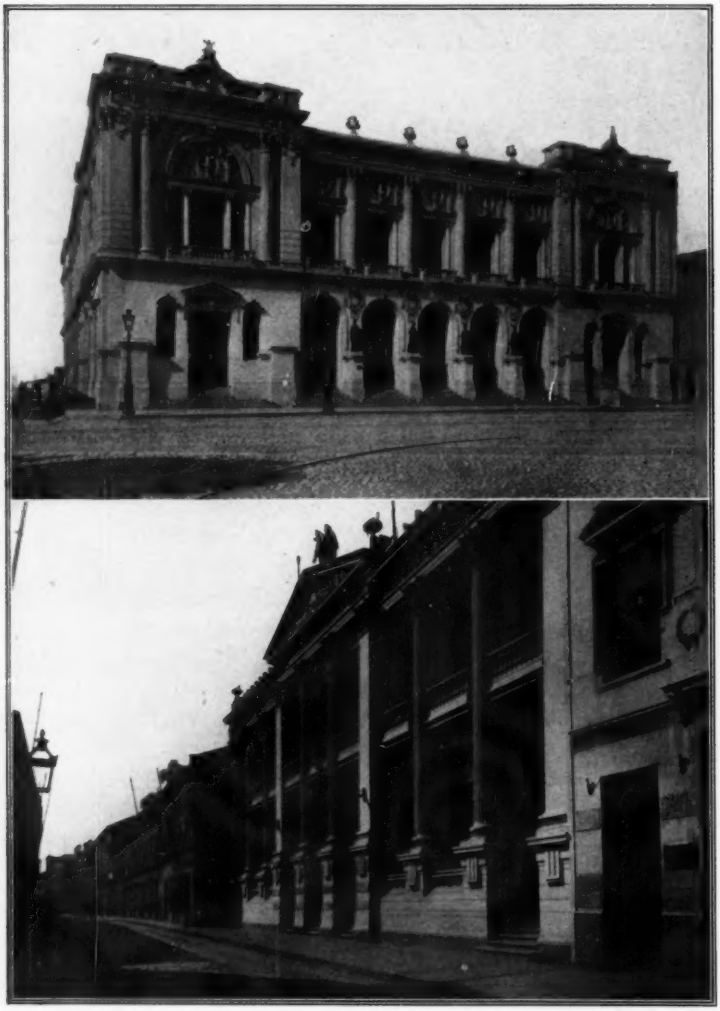
A very important product of Chile is wine, and more than $50,000,000 have been invested in this industry. It will no doubt be surprising to learn that Chile stands second to France in clarets, and that her wines are equal to the best in the world. The climate is especially favorable for wine-growing, and in most of the valleys vineyards are found. Another agricultural industry which promises a brilliant future is the cultivation of beets; the opportunities are apparent when we consider that the country buys about $10,000,000 worth of sugar annually. The government has recently passed a special law in connection with this industry providing a bounty of 2 cents a kilogramme on refined sugar produced in the country. Chile raises the



VALPARAISO. COMPLETING THE PANORAMA SHOWN ON THE OPPOSITE PAGE.

finest line of livestock that can be found anywhere, and throughout the farms of Chile you will find the greatest interest in blooded stock. An excellent quality of wool is exported; everywhere in the southern republic the spirit of progress is evident and the saying seems justified which often classes the Chileans as the "Yankees of South America." In fact, after years of travel through the various countries of South America, there is no place I have visited where the spirit of progress is so much shown as in Chile. This progress is remarkable when we take into consideration that the country gained its independence from Spain less than ninety years ago.

Santiago is the metropolis of Chile, and has often been termed the "Paris of the Western Hemisphere." To it the wealthy persons of the provinces go to settle down after they have made their money. It is certainly a beautiful city, with its grand Plaza de Armas, and its long Alameda running the length of the city. In the centre of the city, rising to a height of over 300 feet, is the famous hill of Santa Lucia with its church, restaurants, and beautiful gardens. I went there to have breakfast nearly every Sunday morning during the time I was in Chile.



VICTORIA THEATRE, VALPARAISO, AND BANK OF VALPARAISO.

and admired the wonderful snow-capped Andes, covered with their eternal snow, making a beautiful picture to sit and dream over while you are enjoying your coffee and cigar.

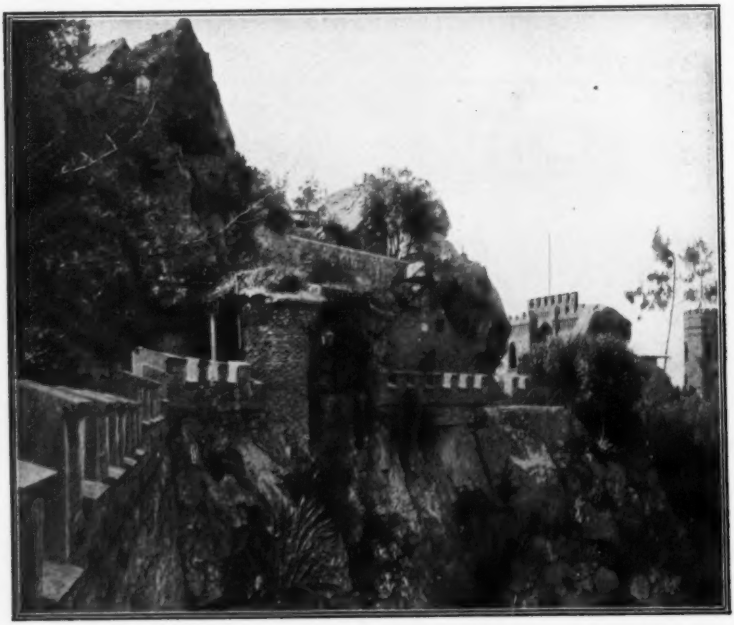
Valparaiso, the leading seaport, is next to San Francisco on the

west coast in magnitude and commerce. It overlooks the blue bay of the Pacific. The streets are lined with fine shops, offices, banks, and warehouses. The loading and unloading of vessels is done by hydraulic power machinery. They have also a long mole in front of the custom houses.

PLAZA DE ARMAS, SANTIAGO.

A Chilean girl cannot be said to possess such liberty of action as an English or an American girl; women certainly occupy an inferior position, due mainly to national custom from which they have not as yet been able to emancipate themselves. The young woman is hampered by an etiquette which deprives her of the opportunity of becoming acquainted with young men, of studying their characters, or of forming friendships with them, except under the eyes of a chaperone. To be courted by one except in this manner would be considered an impropriety, but these customs are beginning to be relaxed somewhat, and woman's right to labor is being encouraged and respected, and in a great many of the shops you will find young women in attendance as in New York. In fact, nowhere else in the world probably is she to be found as a conductor of a street car.

PLAZA PRAT, NEAR THE SHIPPING WHARVES, VALPARAISO.



SANTA LUCIA, SANTIAGO.

A CHILEAN COUNTRY HOUSE, AND A VIEW OF [illegible] MARKET DAY.

Illustrating the agricultural resources of the [illegible] for internal transportation [illegible]

The Chilean woman is a very [illegible] probably keeps the church from utter extinction [illegible]. With

her figure closely enveloped in her manta, which she wears hood-fashion, she goes tripping to church in the early morning, carrying in her hand her prayer book, followed by her servant who carries a yard of carpet or fancy mat, upon which the señorita kneels on the stone floor of the pewless cathedral. No matter what her station in life is, the Chilean girl puts off her bonnet, dons the manta, and kneels in the centre of the church with her worshipping sisters, however poor or despised they may be; thereby putting herself on a level with them and doing away with all the rivalries of dress during church hours. The Chilean girl is certainly very attractive, with her olive complexion, sparkling black eyes, and rosy cheeks. The climate, being more invigorating than in Peru, naturally gives her a better color.

A CHILEAN SENORITA ON THE WAY TO MASS.

The "haciendados" of the country are particularly courteous towards all foreigners, taking them into their houses, and giving them the best of care and attention. A very amusing story is told of one of the representatives of the United States government who was visiting a Chilean gentleman, and being offered a fine pair of horses, accepted them. They were sent the next morning to his house. It is the custom in this country if you admire a thing, for your host at once to offer it to you; but of course it is considered equally a matter of etiquette for you to decline. Indeed, it is very impolite to accept these offers, as the people simply are endeavoring to show you their good will.

The original inhabitants of the country are known in history by the name of "Araucanos" and were savage tribes, which never submitted to the Spanish rule. Some of the descendants of this people are still existent and live on the land which has been set aside to them by the

government, in the part of the territory they fought over for nearly 300 years. The spirit of these people remains in the popular masses and distinguishes the Chileans for their pride, their valor, energy, and aptitude for learning.

A VALPARAISO CONDUCTRESS.

The Araucanian Indians are rather an intelligent looking lot of men about medium height. They have straight hair and the peculiar eyes common to the Indian races. They are of light copper color and dress in the poncho, generally fastening around the waist a blanket which hangs like a short skirt, with a red handkerchief tied around their heads. The women wear the poncho folded like a shawl and coil their hair in tresses around their heads, ornamenting the braid with a string of beads. They wear large silver earrings, often several pairs at the same time, and necklaces of beads or of leather studded with silver ornaments. They generally go barefoot and pin their ponchos with silver ornaments. The women do the weaving and make the clothes for both themselves and the men.

A CHICKEN SELLER IN VALPARAISO.

Bread, fruit, etc., are similarly brought to the door in huge panniers.

TYPES OF ARAUCANIAN INDIANS.

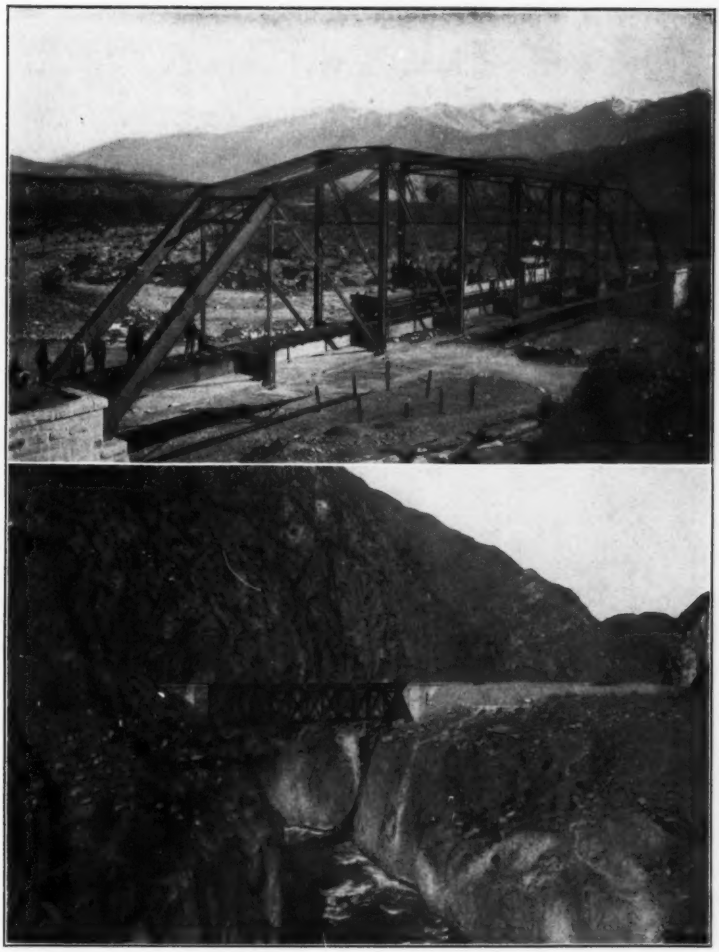
Their huts are usually orderly and clean—a thing which cannot be said of the Peons. They generally have several wives and these with their children dwell together in apparent peace. Their mode of taking wives is similar to a custom which prevails in many barbarous countries. The young man goes to the home of the prospective bride, having settled with her father for her, and forcibly carries her off—at least, he and his friends appear to use force; they are in reality allowed to take the girl away with only a slight show of resistance. The pair then retire to the woods, and after dwelling there together for a few days, they go to the husband's domicile, where they live afterwards as husband and wife. The women have the same custom which prevailed among the ancient Incas—that of going alone to the forest streams at the time of childbirth; when the child is born it is washed in the river, wrapped in a blanket, and bound to a board, where it remains until it is time for it to learn to walk.

THE CORDILLERAS ON THE LINE OF THE TRANSANDINE RAILWAY.

The stream in the upper view is the Rio Colorado. The lower picture is the valley of Los Horcones.

SALTO DEL SOLDADO.

Of engineering enterprises other than mining or the development of water powers, the most important and most immediate in interest is the Transandine railway, which after half a century of stagnation or very slow progress seems at last on the point of energetic prosecution to completion. The Chilean government has called for tenders (which are to be opened at Santiago in May, 1904) for the building of the one remaining link necessary to connect the Chilean lines with the Argentine railways, which now are reported complete to the boundary. The section to be let by Chile is about 25 miles in length, but a considerable part of distance must be in tunnel. It extends from Salto del Soldado (4,100 feet above sea) to the "cumbre," or summit, (12,800 feet). The Transandine railway proper is the entire stretch between Mendoza and Los Andes, but the line is built



BRIDGES ON THE COMPLETED PORTION OF THE TRANSANDINE RAILWAY. THE UPPER ONE IS OVER THE RIO MENDOZA.

from Los Andes eastward to Salto del Saldado and from Mendoza westward to the "cumbre," the route being that known as the Uspallata Pass. When this last link is closed, the journey from Buenos Ayres to Valparaiso will be made in 48 hours, though differences in gauge of various portions of the line will necessitate two or more

NATURAL BRIDGE IN THE CORDILLERAS.

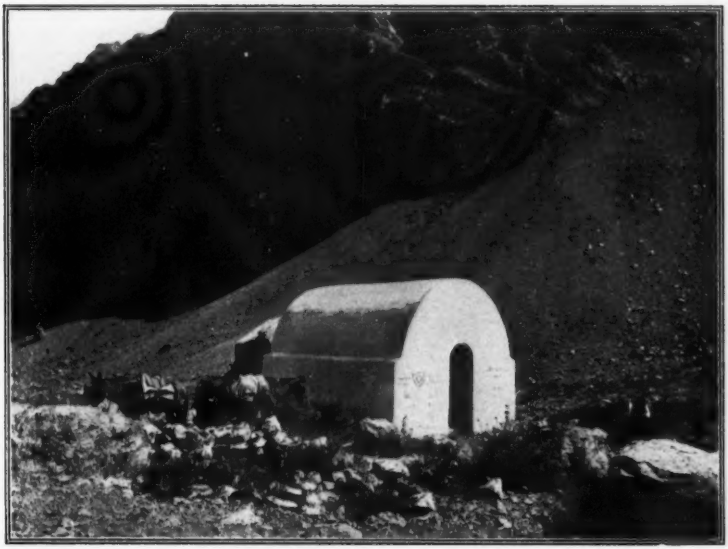
Called "Puente del Inca." It is near some celebrated warm baths, and the formation is largely due to deposits from highly charged mineral waters.

transfers en route. The line is expected to be a paying one, passenger traffic being an important item and the cattle business very profitable, the movement being westward into Chile from the Argentine pastures. I crossed the Cordilleras some years ago from Los Andes, following the line where the railway will run and where the portion reaching Salto del Soldado was then under construction. The dividing line between Chile and the Argentine Republic is marked by a line of iron posts planted on the crests and extending almost to Cape Horn.

The Transandine line is to be of one-metre gauge, and in preceding studies the Abt system has been proposed for several sections aggregating nearly 18 miles. "Works of defense" against the snows and gales of the winter are essential.

The climate of Chile is one of the finest in the world; the temperature varies hardly 25 degrees from the middle of summer to the middle of winter. In coming around the Horn, one passes from cold and stormy weather into this beautiful climate almost as soon as the shores of Chile are sighted. The last trip I made we were five weeks off the Horn, but forty-eight hours after getting around it we found delightful weather, with a good steady trade wind blowing us up the coast. The southeast trades seem to bring up from the Pacific better weather than exists on the Atlantic side of Cape Horn.

When the Panama Canal is finished all the immense amount of material which is now brought around the Horn to and from Chile



A REFUGE STATION IN THE PASSES OF THE ANDES.

The great thickness of the walls is designed to protect the traveller from the severe cold due to the altitude. The only opening is toward the north—the warm quarter.

A PARTY OF ENGINEERS, RECONNOISSANCE SURVEY OF THE TRANSANDINE RAILWAY.

THE FALLS OF LAJA—THE UNDEVELOPED NIAGARA OF CHILE.

will of course be carried through it. The passage through the Straits of Magellan has always been an extremely dangerous one, and a great many fine ships have been wrecked in that fog- and wind-infested region—one of the most desolate of the seas.

CAPE PILLAR, AT THE ENTRANCE TO THE STRAITS OF MAGELLAN.

THE APPRENTICESHIP SYSTEM OF THE ALLIS-CHALMERS COMPANY.

By Philetus W. Gates.

The best technical literature is that which is written about the most important problems by the men who have been most successful in solving them, and who have the faculty of describing their methods clearly. Mr. Gates' article has all three qualities.—THE EDITORS.

THE means adopted by any manufacturing concern for the training of shop-hands or other employees are necessarily an outgrowth of its needs and its environment. That these, correctly interpreted, may lead to widely different policies, is well shown by the diversity between the systems described in this Magazine in December and January last. And yet the system in vogue at the Westinghouse Company is certainly very comprehensive and very good, and the same is equally true in relation to the methods adopted by the Brown & Sharpe Company. As a matter of fact, apprenticeship systems in different works must vary with the conditions there extant and while they may seem diametrically opposed, they may in each instance be the best for that particular concern.

There is no uniform system of apprenticeship in the different plants of Allis-Chalmers Company, although two forms of apprenticeship agreements are being used; one of these is the ordinary apprenticeship agreement and provides only for four-year apprentices, putting all apprentices on a dead level, without regard to technical education or other conditions. The other apprenticeship agreement, which is in full operation at one of the plants, contemplates three classes of apprentices, the first class being four-year apprentices, the second class three-year apprentices, and the third class two-year apprentices. Apprentices of the first class are required to have passed at least the sixth grade in the grammar school, or to have had equivalent education. The second-class apprentices are required to have been graduated from the high school and to have taken a course in manual training. The third-class apprentices are required to have been graduated from some of the universities or some of the manual-training schools, like the Armour Institute, Purdue, Worcester Polytechnic, etc., and to have had the manual training which goes with these schools.

Speaking in general terms, from the first class it is the expectation we will gain our regular machinists, sub-foremen, foremen, and inspectors; from the second class, erecting engineers, general foremen, assistant superintendents and superintendents; and from the third class, salesmen, engineers and technical experts. No set routine has ever been laid out for the different classes, for the reason that the plant in which this form of apprenticeship has been in force is a small concern employing only six or seven hundred men, and the general foremen have been able to give the apprentices personal attention and to direct their progress according to the ability shown.

This form of apprenticeship has been introduced in one of the larger plants for the second and third classes of apprentices, and probably in the near future some general system of service and advancement will be prepared; and if the system is extended to all of the plants, it is more than probable the apprentices will be under the direct supervision of some person selected for this work, as has been done in the case of the Westinghouse and Brown & Sharpe Companies.

It goes without saying, of course, that the apprentice of the first or second class, may, through merit, arise to any position in the company; and as a matter of fact in the plant first mentioned great care has been taken to give the first-class apprentices every opportunity.

In the plant first mentioned, the first-class apprentices are obliged to present an original drawing each month, the apprentice himself selecting the subject. There are offered four prizes each month, the first being $2.00, second $1.50, third $1.00, and fourth, fifty cents, and these prizes are awarded on the basis of progress, not for the best drawing or best subject. When an apprentice has secured a certain number of prizes of any one class, or a combination of classes, he is then exempt from making further drawings, because it is supposed that he is proficient enough for all practical purposes for his class.

In addition to furnishing the drawings, this class of apprentices is obliged to attend some night school, or to take a course in the Scranton School of Correspondence, or some other similar school. The second- and third-class apprentices are supposed to be proficient enough in drawing not to require the same course as the first-class apprentices, but if it is ascertained that they are not able to read drawings or to make drawings properly, they are also obliged to have instruction in this line.

The selection of apprentices is made by the superintendent of the works, or the general foreman, and is not based on the comparative scholarship record, as we have an idea that it is not always the student

who has the best scholarship record that makes the most proficient workman or the best business man. My experience, both at school and as a business man, has been that there are within every young man latent forces which are only brought out when proper opportunity is afforded and that this opportunity must be of a practical nature. The opportunity for a young man to shine in scholarship is, of course, restricted in the largest degree to the superficial knowledge attained from the books and specialties which he is studying, and while a young man may make a very good showing in this direction, when it comes to using that judgment which is necessary to practical conditions, he is not able to do so, whereas another young man, whose showing may approach dullness, may be able to grasp the situation at once and produce results thoroughly satisfactory. In other words, the old saying "You are not able to judge how far a frog may jump by his looks," is applicable in this case, and the only safe and just way, in my estimation, is, after ascertaining that the character of the young man is good, to assume that the fact of his having gone through the course of studying necessary for the grade of apprenticeship which he is to enter is warrant of his ambition, and then give him a chance, weeding him out later on if he should be found wanting.

Probably as this system is extended in the works, it may be found of value to keep tabulated records, as is done at the Westinghouse.

No deposit is required by any apprentice, but on the contrary it is the policy to pay the apprentices such wages as will make them independent of outside support, on the theory that anyone may apply, regardless of financial condition.

The wages for the first class of apprentices are:

For first period of 2,750 hours— 9 cents per hour
For second period of 2,750 hours—12 " " "
For third period of 2,750 hours—15 " " "
For fourth period of 2,750 hours—18 " " "

The wages for the second class of apprentices are:

For first period of 2,750 hours—12 " " "
For second period of 2,750 hours—16 " " "
For third period of 2,750 hours—20 " " "

The wages for the third class of apprentices are:

For first period of 1,375 hours—15 " " "
For second period of 1,375 hours—18 " " "
For third period of 2,750 hours—22 " " "

An apprentice may terminate the agreement any time within the first six hundred hours, and the company can, under the terms of the

agreement, terminate the agreement for incompetency, or any other good and sufficient reason. A vacation of one week is given in each year of service to each apprentice, for good service, and $100.00, $75.00 and $50.00, with a diploma, to the respective classes at the completion of service term, for the same reason.

In each of these classes it is expected that the entire time will be used in the machine shop, in the handling of tools, erecting, etc., unless for special reasons it is thought best to have some parts of the term used in the draughting room. This discretion is exercised more largely in the first class of apprentices. It is our object to have each class become thoroughly familiar with the practical work in the machine shop, believing that there is ample opportunity for pursuing the theory after they have served their time.

I thoroughly believe that it is the duty of every manufacturer to do his utmost to educate competent workmen through the apprenticeship system, but on account of the peculiar conditions obtaining in manufacturing in these days, the range of work in the shop is not always great enough to educate the apprentices properly. I therefore hold with Prof. Sweet, that there should be "Shop Schools" established by the various trades—for instance, that the National Founders' Association should establish one or more schools in different parts of the country, under the direction of a properly constituted committee, this school to be supplied with work, from the different members, in such proportions as are suggested by the committee, the members sending the work to pay therefor at such rates as will assure a profit for the school, or, not being able to do this, to make a money contribution.

Undoubtedly as organized labor is now conducted, there would be much opposition to these schools, but this is a matter which should not deter the manufacturers. It seems to me there are only two questions to be decided in this matter, viz:—"Is it right?" and "Is it good business?" If so, then the manufacturers should forward the work and advocate the idea, as they have had in the past to introduce many advanced ideas and improved institutions, against the opinions of organized labor. They should press the policy with all the vigor at their command, with the certainty that in the long run the plan will succeed and the benefits inure to the fraternity.

Such schools as these would be of great advantage to each trade in many ways known to every manufacturer, outside of simply turning out competent workmen, and it is my belief that the establishment of such schools cannot take place too soon.

WAGE-PAYING METHODS FROM THE VIEWPOINT OF THE WORKMAN.

By Henry Hess.

Mr. Hess's method of analysis is thoroughly scientific, in that it goes to the foundations of the subject and takes account of all the elements entering the problem; and at the same time it is thoroughly practical, in that it is addressed to working conditions and presented in graphic form, making the results instantly and clearly apparent. The paper is the first of three, taking up the advantages of the advanced wage systems from the viewpoint of the workman, the employer, and the invested capital.—THE EDITORS.

IN the entire relation of capital and labor there is probably no detail that is more vital than that of the payment to labor of its share in the return for industrial production. On both sides there is at present a quickening of interest, evident in the consideration given all proposals for reconciling differences arising out of the very humanly selfish desire to get as much and to give as little in return as possible. That this is a prevalent attitude must be clear to all observers of the attempt on the part of some unions and labor leaders to limit and fix the amount of work to be given in return for an also limited and fixed wage, and, on the other hand, of some employers to limit the amount that their men may receive in wages, quite apart from the return in work given.

It would be a libel on the general intelligence and would argue a pessimism not at all warranted by the very real advances made toward equitable dealing, to assume that such an attitude represents fairly that of the generality in the opposing camps; though unquestionably the latent mutual readiness to accord one another fair treatment and credit for good intentions is much obscured by the noisy mouthing of self-constituted leaders, self-imposed upon the tolerant and easy-going majority of both sides. If one were to believe these leaders, the sole aim of the employer on the one hand is to allow the workman to earn the barest pittance in wages in return for as large an amount of work as he can be cajoled or compelled to give; the aim of the workman is represented by the others to be as large a wage as can, by individual and collective bargaining and occasional intimidation, be secured for the least possible labor return. That, too, is the way the situation presents itself to those who can see in employer and employee only necessarily opponent forces. Many of these long for a

return of the old patriarchal relation, forgetting that that had proportionately a far greater number of serious evils in its train than modern conditions at their worst have produced. It is more than probable that its lamentors would be among the first to find the "good old time" not exactly all their fancy painted, should it by any miracle be resurrected; of such return there is however small probability, as even those who regret the departure are agreed that adaptability to modern industrial conditions was not among the virtues of the "good old time."

The entirely legitimate desire to get as large a return as possible for the outlay of capital or work does not involve a necessary antagonism, provided the workman is ready to use his strength and intelligence genuinely, and the employer to consider the wage cost of his product rather than the workman's wage total. Living fairly up to this principle of fundamental equity does away with all serious causes of mutual discontent, as has been proven times without number. The only argument advanced against the principle is based on its leaving each workman unrestricted to increase his output up to the limit of his individual capacity, and the fear of sincere—and because of their very sincerity, dangerously obstructive—leaders that there may not be work enough to go around. Many a workman, and he of the best, has in my own experience, advanced as a reason for not taking advantage of guaranteed piece prices to increase his earnings by amounts readily realizable, that that would mean taking work and opportunity from his fellows. With many there is no reason to doubt the sincerity of this altruistic attitude, even while with others, and those the more evident in the public eye, it is an obviously assumed pose. Time may be safely relied on to bring about an harmonious adjustment, just as the unalterable logic of events has proven the fallacy of the similar belief in the harmfulness of replacing hand work by machinery.

There have been proposed many plans for stimulating the workman's interest in an increase of his production and of assuring him of the genuine identity of his and his employer's welfare. Until lately these nearly all took the form of some profit-sharing plan or other, with no great measure of general success to their credit. Such lack of success was in great part due to the length of time involved before profit distribution could be made, the smallness of the amounts falling to each individual as compared with exaggerated expectations, and the difficulties of dealing equitably with the voluntarily and involuntarily migratory element among the workers. Latterly more

attention has been devoted to plans purposing the direct and immediate participation of the workman in the benefits arising from increased activity on his part, the benefit to manifest itself anew with each recurring payday in the pleasant chink of coin.

The merit of being the pioneer with a well worked out and competently introduced plant is due Mr. Halsey for his "Premium Plan"; from that have sprung many modifications, chiefly in Great Britain, where, especially of late, there has been manifested a much wider interest in the entire question than in the United States, probably owing to the greater intensity of the differences between employer and employed.

Another plan that has attracted much attention here is also of American origin; it has been worked out by Mr. Gantt under the stimulus of Mr. Taylor's highly original methods of works management. The method of paying for work by the piece is essentially of the same type as these more modern plans, and is as old probably as the substitution of voluntary labor for that of the serf and the slave.

Assuming that the workman has arrived at a general willingness to increase his earnings by an increase in his production, that plan of payment will seem to him best that promises the greatest recompense for the extra exertion of mind or muscle involved. An estimate of the relative value of the various plans from this point of view may be arrived at by contrasting the possible earnings per hour for savings of time ranging from none at all to the entire amount allowed. As it is not impossible that the time set for the completion of a "job" may be so short as to be unattainable by some individual workman, the effect of taking more time—that is, of losing time—is also to be considered. The possible earnings per hour may be calculated and tabulated for comparison; but columns of figures are at best difficult of digestion; instead, the facts are here presented in a graphical form on Diagrams 1 and 2, showing at a glance the entire relation of the various plans throughout the range of time saving or time lost. An hour is taken as the base time set; if less time is used that means "time saved"; if more time is occupied that represents "time lost"; the actual "hours used" are taken as the horizontal scale at the base of the diagrams; the vertical scale measures the "earnings per hour." Twenty-five cents per hour is taken as a convenient and readily convertible basis of "earnings per hour" under the ordinary day-pay plan; for other rates the results are naturally directly proportional.

Under the day-pay plan the earnings per hour are constant at 25

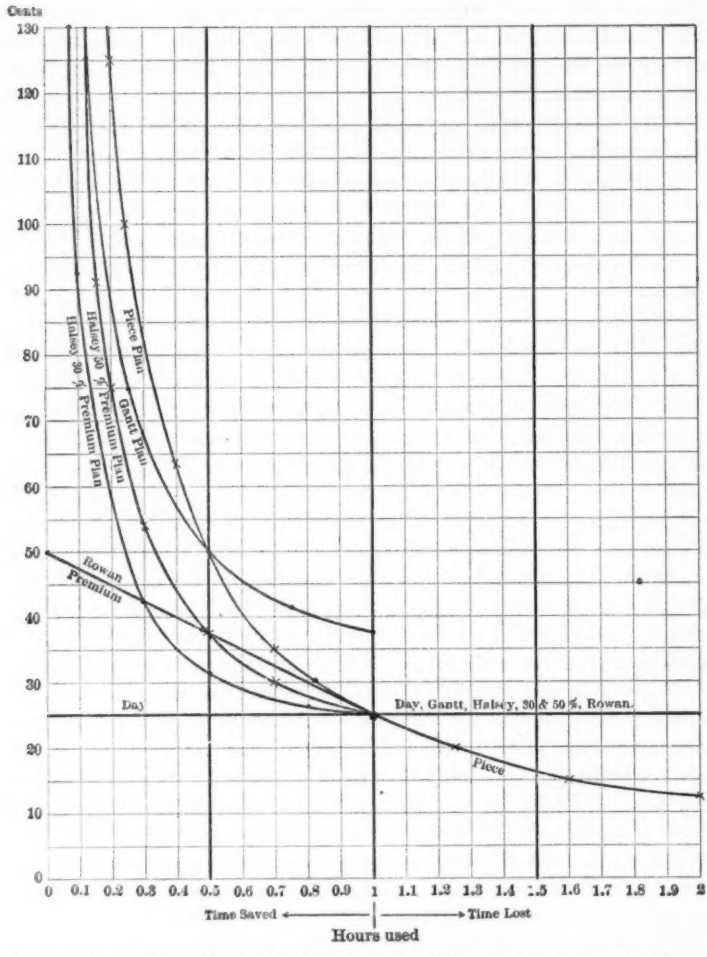


DIAGRAM I. WORKMAN'S EARNINGS PER HOUR, UNDER VARIOUS METHODS OF PAYMENT, WITH A BASE RATE OF 25 CENTS PER HOUR.

cents whether the workman save or lose time. Its characteristic is therefore the horizontal line in the Diagram 1 at a height of 25 cents per hour.

The next plan of general familiarity is that of piece work. Under that a saving of one-half the time would result in a doubling of the

hourly earnings from 25 to 50 cents, while a further increase of production to the extent of using only one quarter of an hour would quadruple the wage takings per hour to 100 cents. The obverse side of the picture is the decrease in hourly earnings when more time is used than was set; a doubling of the time halves the earnings per hour. The possibilities of this plan are shown on Diagram 1 by the curved line marked "Piece Plan."

The "Halsey premium plan" contemplates the division between the workman and the employer of the savings due to an increased activity; the employer fixes a time—say one hour—for the work, and promises the workman a certain portion of the wage value of all time he may save, guaranteeing that the time rate shall not be changed unless the conditions on which it were based are materially altered; an alteration in the sense contemplated would be the introduction of new machinery of increased capacity. The employer further agrees to pay day-pay rates should the workman not find himself able to save time or should he actually take up more than that set as a base. The premium is that portion of the wage value of the time saved that is accorded the workman. Were the entire value of the time saved given as a premium then the plan would be identical with the piece-work system so long as time is saved, but not if time be lost, as under it the hourly earnings are then constant instead of decreasing. Halsey recommends 30 to 50 per cent. as a premium, the rate to be higher the greater the exertion required to save time. In Scotland a well-known firm of pump builders were the first to adopt the plan on the 50-per cent. basis, which accounts for its being there generally known as the "Weir" plan. The value to the workman of both the 30 and 50 per cent. plans are clearly indicated by the corresponding curves on Diagram 1.

A member of the Rowan firm, engine builders of Glasgow, Scotland, has devised a modification of the Halsey plan that makes the ratio of the premium paid and of the hourly pay rate the same as the ratio of the time saved to the base time. If no time is saved or more than the fixed time is used, the hourly pay is constant as under the Halsey plan. The slanting straight line marked "Rowan Premium" on Diagram 1 shows that when no time is saved the results under all plans are identical; if only a half hour is used instead of the hour set, the Rowan plan gives the same earnings per hour as the Halsey 50-per-cent. premium; if only 0.3 hour is occupied, the earnings agree with those under the Halsey 30-per cent. plan. The returns are throughout less than under the piece plan, but for the first, and therefore most easily made, time savings are greater than with the other plans.

Mr. Gantt fixes a certain time as that in which a piece should be done; if that time is reached the workman receives a bonus in addition to his day rate for the time occupied; if he does not reach that time, he is paid at his day rate. The time for the receipt of a bonus is so fixed that a competent workman should earn from 30 to 70 per cent. more than by day pay. The time to be allowed is determined by a careful study of the various elements entering into the doing of the work; the workman is then aided by being given minute instructions to which he is expected to conform. Assuming the average increase aimed at as 50 per cent., a workman having a day-pay rate of 25 cents per hour would receive 12½ cents bonus if he finish his work in the hour allotted, and raise his earnings per hour to 37½ cents. If he take but half an hour, his earnings per hour would be 50 cents. It is fair to say, however, that very large savings of time are not contemplated, since the study made is with a view to fixing the highest possible rate of production, taking into account the permanent well-being of the workman. Every possible aid, such as personal attention of his foreman and keeping his machine and tools in the best possible condition, is given him to help him toward the attainment of the time set, and therefore the earning of the bonus. The curve marked "Gantt" is characteristic of the result. The hourly earnings up to a saving of one-half time are better than under any of the other plans; beyond that straight piece-work gives more pay. If more time is occupied than was set, the results for the workman are the same as under all of the other plans. If the time set is reached it is better, in that the workman then receives the bonus of 50 per cent., while under all of the other plans he must save time to receive any, and then only a relatively small bonus unless the time saved is considerable.

It may fairly be assumed that savings or losses of over one-half of the time set will be infrequent; in considering the relative values of the various methods of wage payment, those giving the higher returns within these limits will be the better. In order to mark off graphically the outlying possibilities, dotted lines have been entered on the diagrams from time savings and losses of one half.

While Diagram 1 gives the possibilities of earnings per hour under various systems in direct amounts for a 25-cent base rate, Diagram 2 shows their relative value dissociated from the actual amounts. The arrangement is similar to that of Diagram 1, but a vertical scale of ratios has taken the place of the actual amounts. The returns of the day-pay plan have been taken as the unit of comparison. A glance shows that the Gantt and piece plans are decidedly productive of the

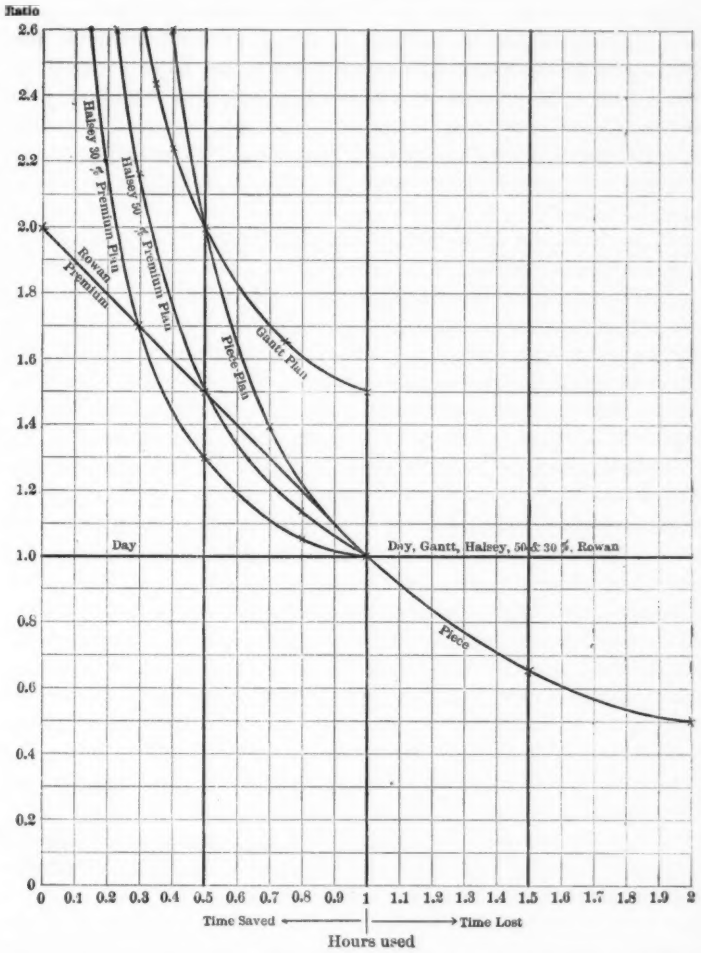


DIAGRAM 2. RELATIVE VALUE TO THE WORKMAN OF VARIOUS METHODS OF WAGE PAYMENT, AS COMPARED WITH DAY PAY.

greatest wage return for time saved; the piece plan involves a loss should the workman for any reason find himself unable to accomplish his task in the time set; the Gantt plan liberal as to the bonus for attaining or bettering the time set is by far the more productive. The ordinary piece plan is fully twice as valuable as the

50-per cent. premium and the Rowan plans when half time is saved, and over three times as valuable as the 30-per cent. premium plan. For lesser time savings its relative value is not quite so great; the Rowan plan most nearly approaches it under such conditions. For those relatively rare possibilities or exceptional workmen that attain time savings of more than one half, the Rowan plan becomes relatively less and less valuable to the workman, and the straight piece plan the best.

Considered purely from the standpoint of the possible returns per hour, the Gantt and the piece plans are seen to be big with the greater possibilities of gain for increased effort. If nevertheless the unions distinctly favor day work, as many do, that is probably owing to the fear that the high wage returns offer a temptation to "cut the rate" that the average employer cannot resist. More than likely the penalizing involved by the piece plan for slower workers also has its influence. If some one or other of the premium plans finds favor it is undoubtedly as a compromise between the fear of a cut on the one hand and a desire of the more progressive and active men to get the returns they know to be possible: The merit of having originated quite an ideal compromise is Mr. Halsey's, in the guarantee it presents of an unchanging base rate and a least hourly wage; it is not at all surprising that this plan and its modifications find more and wider acceptance as they become more generally known. Though of American origin and possibly used in the United States in more individual establishments, England has been more productive of modifications and has been first to give official sanction to the plan at a conference between the executives of the Engineering Employers' Federation and of the Amalgamated Society of Engineers, representing the employers and the unions.

Two other modifications of the Halsey plan deserve at least passing mention. Their originators take the ground that it is not equitable that a workman who for any reason is employed at a lower hour rate should not receive the same total return for his work as his fellow of higher rating, provided he takes the same amount of time for the same "job."

Mr. Isaac Ross, of Leicester, England, therefore provides that half the difference between day pay at the man's hour rate and a fixed piece price be added as a premium to the hourly rate earnings, and the latter only be paid if time is lost.

An Austrian Engineer, Schiller, bases his plan on a similar idea concerning the men having different hourly ratings, and on the further

principle that the wage cost to the employer should remain constant for all time savings by all men having the same hour rate. Schiller proposes to ensure this by varying the base time so as to grant the greater time to the man having the lower hour rate; in order to provide a guarantee that the employer shall grant this increase in time, he appeals to the employer's self-interest by slightly reducing the total wage cost when the work is done by men of low hourly rating; to secure the workman's co-operation, this reduction is made small as compared with the opportunity for increased hourly earnings. If no time is saved the time used is paid for at the simple hour rate. For all men having a similar hour rate the Schiller plan gives results identical with the piece plan when time is saved, and with day work when time is lost.

All of the arguments used by the originators of these two latter plans are in justification of the supposed necessity of a varying hour rate; so long as men do the same work it is difficult to see a really good reason for rating them differently; differences in skill or diligence are taken care of by resulting differences in hourly earnings under every one of the various plans first considered, except day work, without resort to such complicated devices as those of Ross or Schiller. The latter's method particularly entails troublesome calculations in the fixing of the sliding-scale time base that will surely create distrust in the shop. Far simpler is the extension to all men on the same individual operation or "job" of the principle advocated by many unions, of an uniform hourly wage rate for a district for all men of the same class.

From the employer's point of view the various wage-paying methods described are not quite so simple; he must take into consideration the effect of the wage cost of his work on the profit or loss of his business, on the total capital he must employ to conduct it, and on the returns as dividends on his capital. The relative influence of the various systems of wage payment from the employer's standpoint will be considered in the next paper. The workman, too, is interested in this other side, since it is but logical that that system of wage payment that is the more advantageous to both employer and employee is certain ultimately to prevail, as it arrays self-interest and the great majority's inherent desire for fair dealing on the same side.

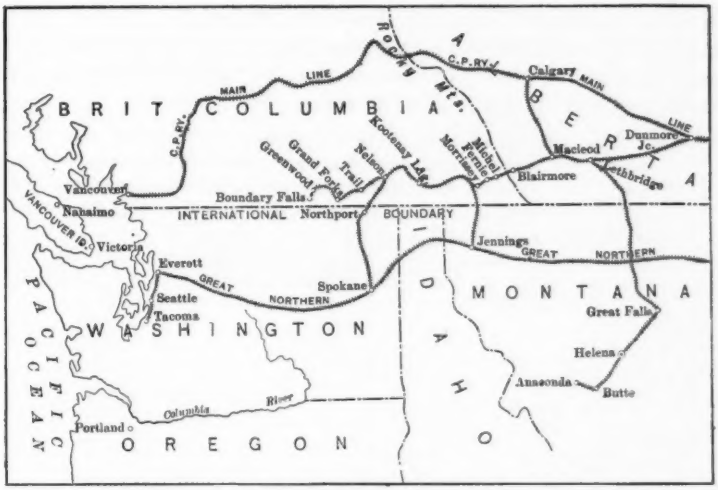
THE COALFIELDS OF CROW'S NEST PASS, BRITISH COLUMBIA.

By E. Jacobs.

The coal deposits described by Mr. Jacobs are destined to play an important part in the mining and industrial development of the Pacific coast—a development which is intimately connected with the fast-making history of the Far East. Mr. Jacobs writes from intimate personal knowledge, and gives a brief but definite outline of the industrial, mining, and mechanical aspects of the field.—THE EDITORS.

THE mining industry of the Pacific Northwest has already attained to considerable proportions and its products are steadily increasing in aggregate value. The share British Columbia has contributed to the comparatively large sum representing the value of this realised natural wealth now amounts to about $210,000,000. Of this total about $65,000,000 was derived from the coal mines of the Province, the production of which mines during the last three years, 1901-1903, averaged in value about $5,000,000 per year.

A review of the coal-mining industry of the northern Pacific coast of America, its present proportions and its prospective very considerable enlargement as more capital shall become available for development and adequate transportation facilities be provided, would direct attention to an expansion the extent of which is not generally realised. But the subject is quite too wide and altogether beyond the scope of this present article. Numerous coal-bearing districts have been discovered in Alaska, on Pacific coast islands, on the mainland of British Columbia, and in the State of Washington. In some of these coal fields, notably on Vancouver Island and in the Crow's Nest Pass region of British Columbia, and in others in parts of Washington, there have been opened up important coal mines now equal to a combined production at the rate of between 4,000,000 and 5,000,000 tons of coal per annum. Of these, the Crow's Nest Pass mines, which are expected to produce in 1904 at least 1,000,000 tons, give promise of becoming the most important coal mines in the Northwest, first because of the unusually large area and great productiveness of the coalfields in which they are situate, and next on account of the fast-growing railway enterprises and mining and smelting industries in large measure depending upon them for their supply of fuel. It is intended, therefore, on this occasion, to restrict investigation to the Crow's Nest



SKETCH MAP OF THE CROW'S NEST PASS REGION.

Pass coalfields together with the adjacent coal-bearing regions of southwestern Alberta.

The Crow's Nest Pass coalfields are situate immediately west of the summit of the Rocky Mountains and about 375 miles due east from the coast. They are in the Fort Steele mining division, East Kootenay, and are about 40 miles north from the International boundary. In the foothills along the eastern flanks of the Rockies, across the dividing line between British Columbia and Alberta, the coal seams of the Crow's Nest country are repeated. But even this neighbourhood does not mark the limit of the occurrence of coal, for eastward for many miles, at Lethbridge and farther still at Souris, mines are being worked in seams of coal varying in quality and character from the lignites of the southeastern portion of the northwest territories to the bituminous coals of the Rocky Mountains. The coal regions also extend many miles northward, for at Anthracite and Canmore, on the Canadian Pacific main line of railway, anthracite coal has been mined for several years.

Coal is said to have been discovered in this part of the country more than twenty years ago. Its stated existence is alluded to in the Report of Progress of the Geological Survey of Canada for 1880-82 (p. 2 B). It is again referred to in the report for 1882-84 (p. 111 C). The coal-bearing area was approximately defined and examined in a pre-

liminary way by Dr. George M. Dawson in 1883. Later, in 1891, after some of the measures had been prospected, it was visited by Dr. Selwyn, also of the Geological Survey, for *The Mineral Industry* (to the end of 1898, p. 200). Dr. Dawson wrote:

> "This coalfield, although it has not yet been fully defined, must have an area of at least a couple of hundred square miles. There are numerous superposed seams, ranging in thickness from 2 to 30 feet, and although the whole series, supposed to comprise about 20 seams, covers only the central part of the field, it is already manifest that we have here one of the most remarkable coal basins known. Dr. Selwyn roughly estimates the coal underlying each square mile, in one part of the field, at 49,952,000 tons. (Annual Report, Geological Survey, Vol. V., N. S., p. 14 A.)"

The history of the development of the Crow's Nest Pass coalfields dates back to 1887. Three years prior to this Lieutenant-Colonel James Baker, an Englishman (brother to the celebrated Baker Pacha and Sir Samuel Baker) who saw service in the Indian Navy from 1844 to 1850, and later in Her Majesty's army, retiring in 1875 with the permanent rank of Lieutenant-Colonel, settled in East Kootenay. Reports of the existence of coal measures attracted his attention and that of Mr. Wm. Fernie, who was afterwards associated with him in forming a syndicate to develop them, and after whom, in 1897, the town of Fernie was named. Every summer for eight or nine years Mr. Fernie took men from Fort Steele to the Elk River district to prospect the coal measures there. Eventually a company was formed to take over the syndicate's holdings, and a charter authorising the construction of a railway to give access to the coal district was obtained from the Provincial Government, of which Lieutenant-Colonel Baker was by this time a member. But about ten years (1887-97) elapsed before these pioneers achieved their object and began to see a return for all their patient and persistent effort. Their reward came with the closing of an arrangement with the Canadian Pacific Railway Company for the construction of the Crow's Nest railway. Meanwhile the Crow's Nest Pass Coal Company had acquired the coal lands.

The Crow's Nest Pass Coal Company was incorporated by Dominion charter in 1897. Its authorised capital is $3,500,000, stock to which amount has been issued, the last $1,000,000 in 1901 at a premium of 150 per cent. It was formed (among other things) "to mine and extract coal and produce petroleum in the Dominion of Canada." It owns in fee simple a large area of coal lands situate on the east side of Elk River, one of the streams draining the East Kootenay district. Its first coal-mining operations, commenced in 1897 were at Coal Creek.

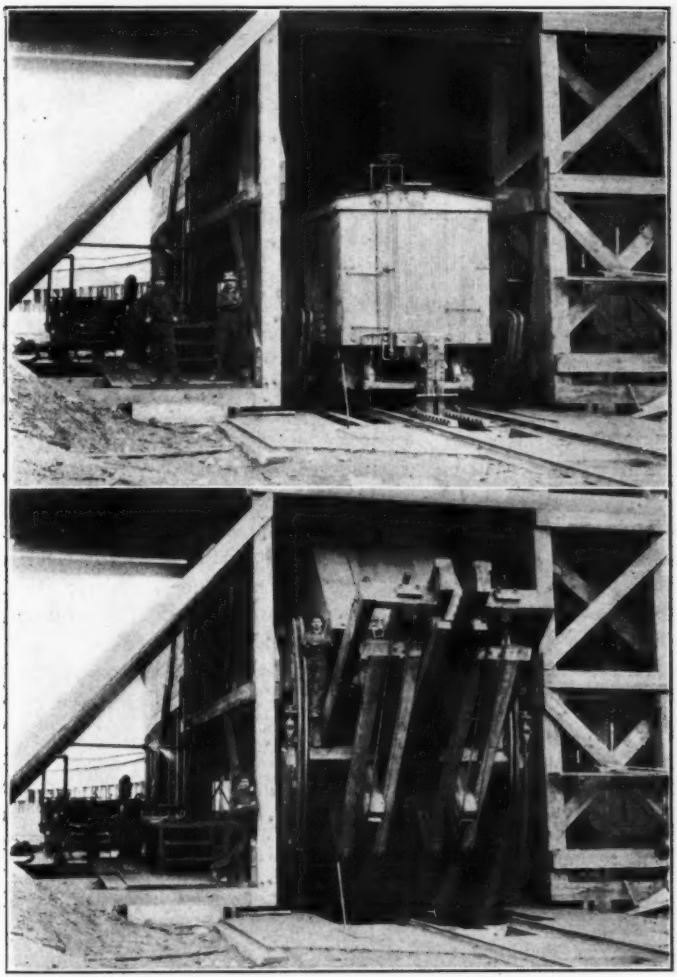
By the time the railway reached this colliery, in the autumn of 1898, there were 8,000 or 9,000 tons of coal on the dump awaiting shipment. The Coal Creek colliery is situate about four miles east of Fernie, a prosperous town established on Elk River by the Coal company, its 3,000 inhabitants being supported chiefly by the coal-mining, coking, and lumbering industries of the district. Later other mines were opened, first at Michel, 23 miles by rail nearer to Alberta, and next at Morrissey Creek, 13 miles by rail in the opposite direction.

At Coal Creek colliery there are six mines on four seams all of which have a north and south strike and a dip to the east of about 15 degrees. The largest of those is a 30-foot seam of soft coal. Coal Creek valley here is about 900 feet from bank to bank, and a high trestle affords convenient connection between the mines on one side and those on the other. The railway runs under the bridge, there being five separate tracks for the cars by which the coal is shipped. There are two tipples here, and other plant in keeping. At Michel there are six producing mines in active operation and two others being opened up. Six seams are being worked on the south side of the valley of Michel Creek and two on the north. Here, too, the valley, which is about 1,100 feet wide, is bridged, and there are four separate railroad tracks on which to load coal for shipment. At Morrissey Creek there are five mines in operation, all on the north side of the creek and each on a separate seam of coal. The coal on the south side of the creek is under separate ownership, and is not yet being worked. The Morrissey colliery, in addition to having an up-to-date plant in other respects, has included in its equipment an automatic box-car loader, the only one of its kind in British Columbia, and one of the very few in use anywhere. Being an entirely new departure in engineering in this connection, it is one of the most interesting features of the equipment of the Crow's Nest Pass collieries.

In the operation of this loader the box cars are run onto a tilting platform and securely locked thereon. One end of the platform is then tilted down and the coal allowed to run into the car until the lower half is loaded. The car is then brought back to a horizontal position and, whilst the coal is still running in, it is slowly tilted in the opposite direction. The tilting is continued up to the maximum of about 35 degrees at which the car is held until fully loaded. By exercising care in tilting the second end very little of the coal from the end first loaded will run down when the unloaded end is lowered for tilting. The platform is supported by vertical sides each of which is a sector of a circle, the centre being 8 feet above the track and the arc 150 degrees long. The

combination of platform and sides is called the cradle. These semicircular sides have tires or rims of railway T rail and are supported by cast rollers. These rollers, two on each side of the cradle, are spaced 60 degrees apart, 30 degrees each side of the vertical. On each side of the cradle and tangent to the semicircular rim at the bottom is a horizontal hydraulic cylinder which is movable longitudinally and has each end attached to the opposite side of the rim by a wire rope which circumscribes the rim from the bottom to near the top, were it is attached. By means of a moderately high pressure pump and a four-way cock, water is forced into corresponding ends of the cylinders and allowed to escape from the other ends. The cylinders thus travel longitudinally and by means of the wire rope cause the sides of the cradle to roll upon the supporting rollers and the platform to tilt. To handle box cars of 80,000-pounds capacity requires a water pressure of 250 pounds per square inch, the cylinders being 13 inches diameter. The device is both ingenious and thoroughly effective. It is singular in that it provides for placing the car in the machine instead of the machine in the car as other contrivances previously invented had done.

A detailed description of the mines of these several collieries would require more space than is available here. With one exception the system followed in them is the pillar and stall, worked in panels, but the coal is conveyed in chutes from the faces to the gangways, where the mine cars receive it. Main haulage at Coal Creek is in some of the mines by electric locomotives and in others by main and tail rope. At both Michel and Morrissey it is by rope, with steam locomotives outside the mine workings. Secondary haulage at all three collieries is by either electric or compressed-air hoists, with horses or mules wherever these can be used to advantage. To provide room for handling the increasing output of coal and for better ventilation, these mines being gassy, the company has introduced the three-entry system—that is, a main and two parallels—in all new mines, instead of the two-entry adopted in mines they opened earlier. Ventilation is by fans, all the later installations being of large fans designed by Mr. W. R. Wilson, formerly general manager for the company. These fans are reversible, for either forced or exhaust draft. Here they are worked as exhausters. They are of a capacity of 250,000 cubic feet of air per minute. The following are instances of the conditions under which they operate: One at Michel, of 8-feet face and 16-feet diameter, discharges 95,000 cubic feet at water gauge 1.4-inch. It is driven by a 16 by 18 Erie City side-crank steam engine; speed of engine 60 revolutions and of the fan 104 revolutions. One at Coal Creek, 12-feet face and 16-



GRAVITY HYDRAULIC BOX-CAR LOADER, MORRISSEY COLLIERY.
The invention of Mr. S. Kedzie Smith, C. E., now of Billings, Montana.

feet diameter, discharges 150,000 cubic feet at water gauge 0.9-inch, and one at Morrissey, 8-feet face by 16-feet diameter, discharges 120,000 cubic feet at water gauge 1.5-inch.

The arrangements for screening, sorting, and loading the coal on railway cars comprise main tipples with Phillips' automatic cross-over

SURFACE WORKS AT MORRISSEY MINES. TIPPLE AND BOX-CAR LOADER BUILDING ON EXTREME LEFT.

car tips; chutes fitted with double sets of screens for screening and sorting coal, which is shipped as "run-of-mine," "full-screen" and "full-screen and nut," and Link Belt Engineering Company's picking tables, operated by rope transmission, for dry-cleaning. No washing is necessary, there being very little dirt with the coal.

At Michel the slack coal is collected in pockets, conveyed to an elevator, and discharged on a second conveyor which distributes to the slack bunkers as required. These bunkers have a total holding capacity of 3,000 tons. At the other collieries the conditions necessitate a departure from ordinary methods, for owing to there not being room in the valleys for a sufficient number of coke ovens these are built away from the mines (the Coal Creek ovens are at Fernie and the Morrissey ovens a shorter distance from the mines) and the slack is loaded directly onto railway cars and hauled to big slack-storage bins erected near the ovens.

The coke ovens are of beehive shape, diameter 12 feet, and have a circular "eye-hole" or chimney at the top. They are built in double rows, of fire brick, with supporting walls and piers of stone masonry filled in between with fire clay. Double-side-discharge steel larry cars charge the ovens with 6½ tons of slack each. The cars are hauled by light standard-gauge steam locomotives. The production of coke per charge is from 3.90 to 4.22 tons, this being at the rate of 60 to 65 per cent. of the charge. The time of burning is 60 to 72 hours, which

gives a daily production per oven of 1.3 to 1.6 tons. No provision is made to recover the bye-products. The coke is cooled and the dirt washed off by hose-watering inside the ovens. Thus treated it contains less moisture when drawn from the ovens onto the shipping wharves. The coke is generally long, lustrous, and firm, containing up to 94 per cent. fixed carbon, 4.50 per cent. ash, and 0.75 per cent. sulphur. There are 424 ovens at Fernie, 464 at Michel, and 240 at Morrissey, together 1,128 ovens. These are easily equal to a maximum daily production of about 1,500 tons. A considerable number of the Michel and Morrissey ovens were only recently completed.

The approximate producing capacity of the several collieries when they were visited last January was a follows:—Coal Creek, 1,300 tons Michel, 1,500 tons, and Morrissey, 900 tons; total 3,700 tons per diem. A steady increase on this output is being made as development proceeds. The total output for six years was as under:

Year.	Coal.	Coke.
1898	8,986 tons.	361 tons.
1899	116,200 "	29,658 "
1900	232,345 "	72,810 "
1901	425,457 "	125,085 "
1902	441,236 "	120,777 "
1903	661,118 "	167,739 "
Totals	1,885,342 "	516,430 "

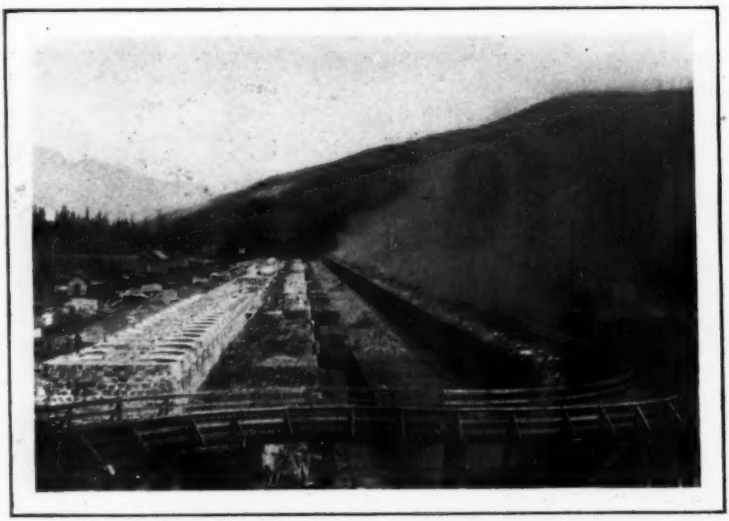
COAL CREEK MINES, FERNIE, B. C. THE SURFACE WORKS.

Of the foregoing gross output of coal nearly 1,000,000 tons (less what has been used under the collieries' boilers) have been sold and the remainder made into coke. The output for 1902 was unfavourably affected by a series of adverse circumstances, the most serious of which were a disastrous explosion which wrecked two of the most productive mines at Coal Creek, and labour troubles at all three collieries. The proportion of total output for 1903 contributed by each of the three collieries was as follows:

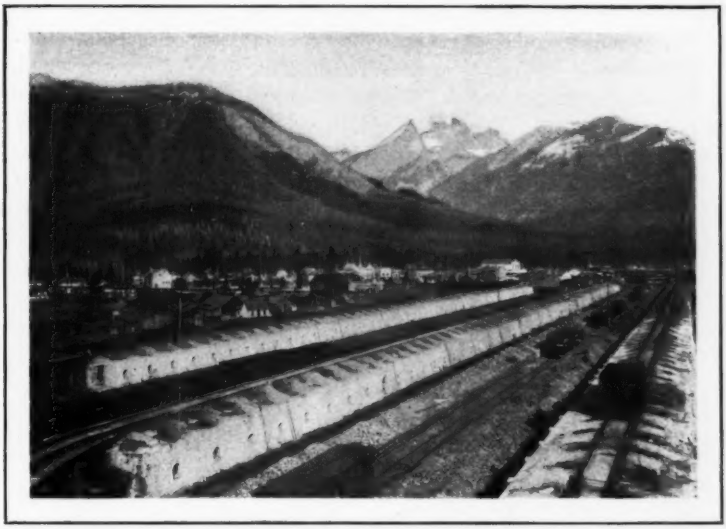
Colliery.	Coal.	Coke.
Coal Creek mines	242,673 tons.	94,441 tons.
Michel mines	263,590 "	72,598 "
Morrissey mines	154,855 "	700 "
Totals	661,118 "	167,739 "

The coal exported to the United States in 1903 amounted to 162,952 tons. Of the remainder of the year's total production about 280,000 tons went to the coke ovens and 218,000 tons were sold in Canada. There were 31,089 tons of coke exported to the United States and the remainder of the total quantity produced was sold in British Columbia.

The average number of men employed at the company's collieries



COKE OVENS BUILDING AND IN OPERATION AT MICHEL.
Locomotive and larry cars to the right. Box cars at wharves in center.



COAL CREEK COLLIERY. COKE OVENS AT FERNIE.

in 1902 was 984, and in 1903, 1,450. About the middle of last December the number of the company's payrolls was as follows:

	Miners.	Oven men.
Coal Creek colliery	427	117
Michel "	583	105
Morrissey "	291	25
	1,301	247

Miners, as above	1,301
Men on general construction work	250
Management, engineering and clerical	37
Total	1,835

The Dominion Government and the Canadian Pacific Railway Company both hold valuable coal lands in the Crow's Nest Pass country, and the latter has done development work in several parts of the fields with a view to eventually producing coal. There are besides large areas owned by individuals or organisations, but so far no work of importance has been done towards making them productive. In the Blairmore-Frank district, though, there are several companies at work. The pioneer company was the Canadian-American Coal & Coke Com-

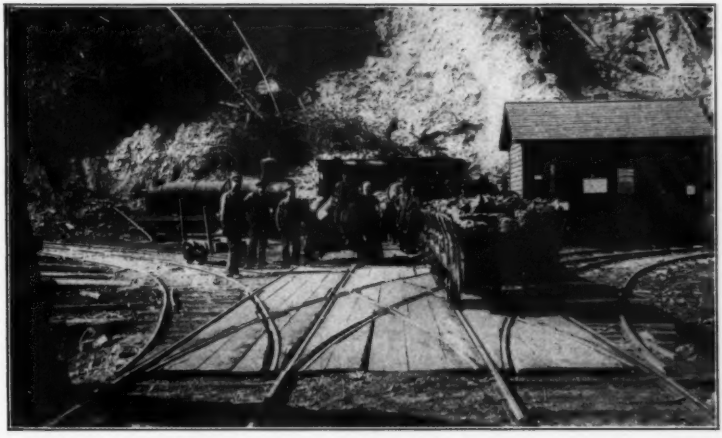
pany, which has been working a mine at Frank for several years. The West Canadian Collieries Company is a consolidation of several properties previously operated by either companies or private firms. This consolidation comprises the Grassy Mountain, Lille, Belleview and Proctor-Fishburn-Baker coal lands. Quite recently the International Coal & Coke Company acquired valuable coal lands at Coleman, near Blairmore, and mines are being opened up, coke ovens built, and railway shipping facilities provided with the object of reaching a daily production of at least 1,000 tons of coal before the current year shall close. This company is preparing to supply coke to the Granby Company for its smelter at Grand Forks, Boundary District. There are other coal properties that have been more or less prospected, but the more prominent in the district are those above-mentioned.

BUILDING COKE OVENS AT MICHEL.

Two railways give the Crow's Nest Pass coalfields access to markets for their coal and coke. The Canadian Pacific Railway Company's Crow's Nest line leaves its transcontinental line at Dunmore Junction, Alberta, reaches Lethbridge at 107 miles, Coleman at 202 miles, Michel at 224 miles, Fernie at 247 miles, Morrissey Junction at 256 miles, and Kootenay Landing at 394 miles. From Kootenay Landing to Nelson the distance is 52 miles, of which distance 32 miles, to Proctor, is by water, the freight cars being transferred to large scows or barges each carrying ten cars. Smelting points in British Columbia

reached by C. P. R. are distant from Fernie, where are the coke ovens of the Coal Creek colliery, as follows:

Nelson, West Kootenay	199	miles.
Trail, " "	251	"
Grand Forks, Boundary	295	"
Greenwood, "	317	"
Boundary Falls, "	321	"



MAIN ENTRY TO MINES NOS. 3, 4, AND 5, MICHEL COLLIERY, SHOWING TRACKS TO OTHER MINES.

The distances from Morrissey, colliery ovens, to which a four-mile spur runs from Morrissey Junction, are five miles less than those given above, whilst from Michel they are thirty-two miles more. From Fernie east to Lethbridge the distance is 140 miles, or from Michel 117 miles. From Lethbridge to Montana smelting points the distances are as under:

To Great Falls	215	miles.
" Helena	314	"
" Butte	387	"
" Anaconda	413	"

Connection is made with these several points over the Great Northern Railway Company's Great Falls and Sweet Grass line. Fuel shipped from Frank, Blairmore, or Coleman, all in southwestern Alberta, would have to be transported 89, 91 or 95 miles, respectively, from those points to Lethbridge.

The Great Northern taps the Crow's Nest Pass coalfields on their western side by its line from Jennings, Montana, to Swinton, British Columbia, at the latter point connecting with the C. P. R. at Morrissey

Junction, one mile, and Morrissey mines, five miles. The distances from Jennings to the several collieries are:

To Morrissey Colliery	.....	104	miles.
" Coal Creek "	(Fernie)	114	"
" Michel "	.....	137	"

Jennings being on the Great Northern's transcontinental line the foregoing mileage will serve to show the distance coal has to be hauled to reach that line. The Great Northern also has a road from Spokane, Washington, north to Nelson, B. C. Coke is obtained from Morrissey for the smelter at Northport, Washington, a few miles south of the International boundary. If hauled via Jennings and Spokane, over Great Northern tracks all the way, the distance is 405 miles, but if taken by C. P. R. to Nelson (194 miles) and thence over the Great Northern Company's Spokane Falls & Northern Railway, the distance is 265 miles. These railway distances are given with the object of showing how the coalfields are situated in relation to railways and smelters, which will be their largest customers for fuel, the former for coal and the latter for coke.

For the purpose of showing exactly the quality of the coals of the Province, a series of analyses were made in 1902 at the Provincial Government Laboratory of 20-pound samples of as many of the work-

SURFACE WORKS AT MICHEL, LOOKING NORTH. COKE OVENS IN BACKGROUND ON THE LEFT.

SURFACE WORKS, MICHEL LOOKING WEST.

ing coal seams as it was possible to obtain reliable and average samples from. In order that these analyses should have commercial value the samples were taken from the mines by the Government mine inspectors, who were instructed to take fair and honest samples of the coal *as it can be mined for shipment*, not selected samples. The results, being on average samples, were somewhat lower than could have been obtained from selected samples, but they indicated an exceedingly high grade of bituminous coals. Those from the Crow's Nest Pass mines were nine in number, and they averaged as follows: Moisture, 0.91; volatile combustible matter, 19.1; fixed carbon, 69.93; ash, 9.83; sulphur, 0.32. The total fuel, i. e., the volatile combustible matter and fixed carbon added together, in these nine samples ranged from 75.38 to 95.55.

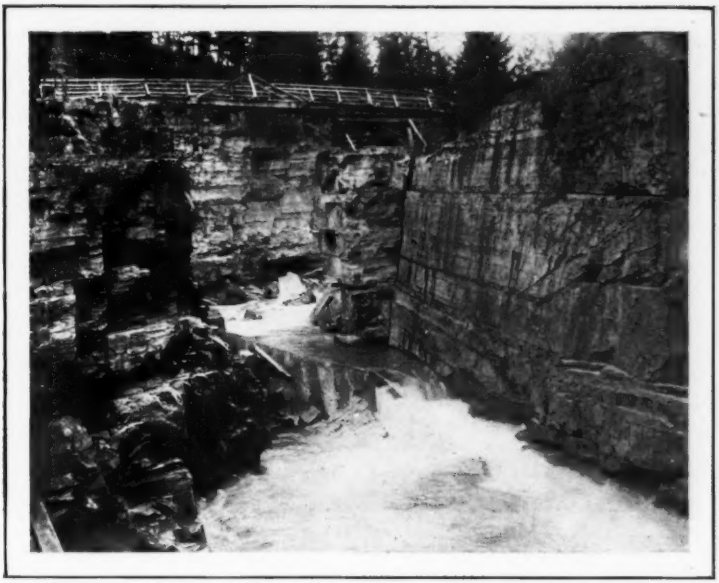
The superiority in quality of the coal found in the Rocky Mountains over that occurring farther east is very noticeable. The following table will serve to exhibit the transition from lignite to bituminous coal:—

	Rocky Mountains	Alberta.		
	Anthracite.	Blairmore.	Lethbridge.	Souris.
Moisture	0.71	2.07	12.08	16.92
Volatile	10.58	22.84	26.87	38.58
Fixed carbon	82.14	68.35	54.93	40.72
Ash	6.57	6.74	6.12	3.78
	100.00	100.00	100.00	100.00

Mr. James McEvoy, then a member of the Geological Survey of Canada, spent the field-work season of the year 1900 in examining this extensive coal-bearing area. His report on it was published in the Summary Report of the Geological Survey Department for the year 1900 (pp. 85-95), and later the department published a geological and topographical map (Catalogue number, 767) of these coalfields. During the 1901 and 1902 seasons a considerable area of the coal belt, both the Crow's Nest Pass and the Blairmore-Frank fields, was investigated by Mr. W. W. Leach, also one of the Survey Department geologists, and his reports were published in the Summary Reports for 1901 and 1902 respectively. The latter was accompanied by a geological sketch map (No. 808) with cross-sections. All these publications are obtainable at low cost from the Geological Survey, Ottawa, Ontario. The reports are too long to be reproduced here, so only a summary can be given. Mr. McEvoy states that:—

> "The area of Cretaceous rocks in this vicinity is nearly 500 square miles in extent. The coal measures, originally deposited over the whole area, have been eroded away around the edges, where the rocks are crumpled and folded, and along some of the deeper valleys penetrating well into the area, so that their actual area is approximately 230 square miles. In shape, the area covered by the coal measures, like that of the Cretaceous basin itself, is, roughly speaking, a long pointed triangle, with its base to the south. Its greatest length is about 35 miles, north and south, and its greatest width about 13 miles. These figures are of course only approximate. . . . . The Crow's Nest branch of the Canadian Pacific railway, descending Michel Creek on the west slope of the mountains, crosses the northern part of the coal lands. It then follows the Elk River downward, nearly along the line of the western boundary of the Cretaceous area, for a distance of about 25 miles. The upturned western edge of the Cretaceous rocks forms a ridge or escarpment which runs parallel to the Elk River and three or four miles distant therefrom. The height of the escarpment is fairly uniform, being 3,500 to 4,000 feet above the river. About half-way up the slope the coal measures are found outcropping with dips of 30 to 40 degrees eastwards. . . . . Although in general the Cretaceous rocks are said to have assumed the form of a flat-bottomed basin, there are many places where local faults have destroyed the symmetry of this arrangement. Some of these faults are of considerable dimensions, and form an important factor to be reckoned with in the problem of systematically mining the coal."

In order to obtain an idea of the character and thickness of the Cretaceous rocks occurring in the basin a section was measured on the front of the escarpment, about three miles north of what is now known as Morrissey Junction. The site selected was on a small spur from the escarpment, where, some years before, excavations had been made on



HORIZONTAL STRATA IN CAMBRIAN ROCKS, ELK CANON, SEVEN MILES SOUTHWEST OF MORRISSEY.

Characteristic of the formation west of the coal area.

the outcrop of the coal seams. The crest of the spur has an average slope of nearly 30 degrees. An exceptional opportunity was here afforded of getting an unbroken section of nearly 5,000 feet. The actual thickness of strata measured was 4,736 feet 3 inches and in this there were found to be 24 seams of coal having a total thickness of 216 feet 2 inches. Of these there were two of a minimum thickness of one foot and two of a maximum of 46 feet. Mr. McEvoy observes: "Of the above thickness of coal the greater part, 198 feet, occurs in a thickness of measures of 1,847 feet. . . . Deducting some of the smaller seams, say three feet and under, that could not be profitably mined, it may be safely concluded that there is a total thickness of workable coal of at least 100 feet." Continuing, Mr. McEvoy described the beds above and below the measured section, and gave an estimate of 12,000 to 13,000 feet as the total thickness of the Cretaceous rocks deposited in the area under notice. He made a comparison between three seams occurring in part of the measured section and those then being worked at Coal Creek, distant about seven miles to the

CROW'S NEST MOUNTAIN (7,800 FEET) AND THE SEVEN SISTERS, AMONG THE EASTERN FOOTHILLS OF THE ROCKY MOUNTAINS.

Crow's Nest is a mass of lime rock thrust through the prevailing Cretaceous.

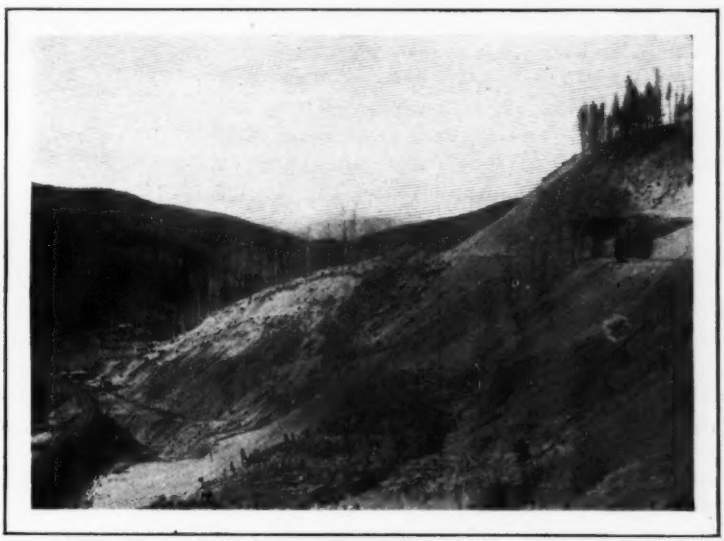
northward. From this he deduced that while there is at Coal Creek a great diminution in size of the intervening beds, the coal seams are fairly persistent. The openings at Michel, 16 miles north of the mines on Coal Creek, expose three seams of coal 15 to 17 feet in thickness, but there was not then sufficient evidence to correlate them with those at Coal Creek. What there was, however, tended to show that some of the seams at least have a greater thickness at Michel than they have to the south.

In the part of the coal lands north of Coal Creek there is no very great area intact, but as there are several points from which the measures can be conveniently worked no excessive underground haulage will be necessary. The coal seams do not reach any great depth, being almost entirely above the level of the Elk River. The measures lying south of Coal Creek, however, occupy a practically unbroken block of country twelve miles or more in width and of somewhat greater length. Along the front, by the Elk River, the beds continue to hold uniform easterly dips and behave in a similar way to that seen on Coal Creek. Morrissey Creek makes a slight indentation in their outline. A section eastward from Morrissey Creek would show that the meas-

ures, after first bending to a horizontal position, rise a little and then slope steadily downward until, at a point three or four miles from the eastern edge of the basin, they reach the lowest depth in the whole area. Owing to the depth of the measures here it is doubtful whether this part of the coal can be profitably extracted. For the greater part, though, the conditions for mining are favourable enough. Mr. McEvoy's estimate of the total available supply of workable coal is as follows:

"Total area of coal lands, 230 square miles, equal 147,200 acres.
"One acre with 100 feet of coal would yield... 153,480 tons of 2,240 lbs.
"50,000 acres would yield..... 7,674,000,000 " " "
"147,000 acres would yield.....22,595,200,000 " " "

Mr. Leach spent part of the season of 1901 in examining Marten Creek and the upper valley of the south fork of Michel Creek. In his published report he mentions that the coal measures outcrop in this valley at a point about 10½ miles from "the Loop" and at an elevation of about 900 feet above the railway. This valley affords a comparatively easy grade for a branch railway and, as it is fairly wide and flat-bottomed, there would be ample room for coke ovens and other neces-



THE EAST LOOP ON CROW'S NEST RAILWAY, AND ENTRANCE TO TUNNEL.

Nearly three miles are travelled to gain less than 200 feet in elevation. The tunnel will improve conditions somewhat.

sary structures. In a measured section of 921 feet 8 inches there were found twelve seams of coal ranging in thickness from 8 inches to 25 feet 2 inches, and aggregating 69 feet 6 inches. A comparison of this section with one measured at Morrissey showed the coal seams to be "fairly persistent, considering the fact that these two points are ten miles apart. The intervening beds, however, show a wider variation with a decided tendency to thin out, in the lower part of the section at least."

Part of the Green Hills area, situate on the east side of the Elk River, commencing about 24 miles above the junction of Michel Creek with the Elk and extending an unknown distance northwards, was also examined by Mr. Leach. Twelve coal seams were noted outcropping along the crest of a ridge in the Green Hills. These seams ranged in thickness from 0.75 foot to 35.5 feet, and gave a total thickness of 89.5 feet of coal in measures aggregating 3,386.5 feet.

In 1902 Mr. Leach examined the Blairmore-Frank coalfields, which are in Alberta, a few miles east of the summit of Crow's Nest Pass, and are separated from the Crow's Nest coalfields proper by the main range of the Rocky Mountains. To the south they are cut off by the Devone Carboniferous rocks of the Flathead range. To the north the limit of coal-bearing rocks is not yet defined. Eastward the belt of Lower Cretaceous coal-bearing rocks extends about 14 miles from Crow's Nest Lake, when it is overlaid by rocks of Upper Cretaceous and Laramie age, also coal-bearing but to a lesser extent.

In comparing the Middle and Lower Cretaceous rocks of this area with those of the Crow's Nest Pass coalfields, a general similarity is at once seen, with, however, a very marked diminution in thickness in the rocks of this district, especially in the case of the lower dark shales underlying the coal measures. The geological structure of this area is somewhat complex, much faulting and folding being in evidence. Two sections across the coal-bearing rocks were measured. In one, in the northern part of the area examined, twenty-one seams of coal, ranging in thickness from 15 inches to 15 feet 3 inches and giving a total thickness of 125 feet 3 inches of coal, were found to occur in an aggregate of 742 feet of measures. The other section was in the southern part of the area. This section as measured was 479 feet 9 inches and in it there were eleven seams of coal varying in thickness from 3 feet 3 inches to 12 feet, and totalling 101 feet 9 inches. There was very little resemblance found to exist between these two sections, but as the two points at which measurements were made are 23 miles apart, uniformity was not looked for.

Among Mr. Leach's comments were the following:—

> "The coals and lignites of the Upper Cretaceous and Laramie have been opened up in several places, chiefly to supply the local demand for domestic fuel. In most cases, however, the highly contorted condition of the strata renders mining difficult and uncertain. . . . It is now proved without a doubt that very large deposits of coal exist in this area, but success in future mining operations will depend largely on the selection of the best available sites. In this connection several factors have to be taken into consideration, such as the quality of the coal, transportation facilities, the absence of faulting, and the altitude of the coal seams themselves. With regard to the last-mentioned, it is the general opinion among local mining men that, for the present at least, the coal below the level of the valleys cannot be profitably extracted in competition with that won by drifting into the mountain sides and requiring no hoisting or pumping machinery."

In conclusion, too much prominence cannot well be given to the important bearing these coalfields have upon the economic future of the country within a radius of say 250 to 350 miles of them, and possibly over a wider area. Industrial enterprises will for many years be largely dependent upon them for main supply of fuel. A considerable increase in the mileage of railways throughout the country that will draw upon them for the coal is looked for, and that, too, within a few years. As already shown, the main lines of the Canadian Pacific and Great Northern railway systems are within easy reach. The C. P. R. at Calgary (via the Macleod branch) is only 170 miles and at Dunmore Junction about 200 miles from the Blairmore-Frank fields, with no heavy mountain grades between. Michel is but 25 miles farther away, and as the summit of the Rockies, 16 miles east of Michel, where crossed by the Crow's Nest line, is little more than 600 feet higher than the coal mines, the cost of haulage eastward is not prohibitory. The Great Northern at Jennings, on the west of the Rocky Mountains, is but 104 miles from Morrissey, with a grade suitable for heavy train loads; whilst on the east of the mountains, Great Falls, on the same transcontinental railway, is within 300 miles of the the Blairmore-Frank mines, also without heavy grades. Then as to smelting centres:—Great Falls and Helena, two Montana smelting points, are, respectively, about 300 and 400 miles distant from the coke ovens, in one direction, whilst to the west Nelson is reached at 200 miles, Trail at 250, and Boundary points at 290 to 320 miles. The growing importance of the smelting industry of the Boundary district was indicated in THE ENGINEERING MAGAZINE last November (p 249). For some time mines and manufactories will also require an

appreciably large amount of coal, but the development of the water powers of the country with attendant electrical transmissions must be taken into account as an eventual competitor in this direction. Then, too, there will be a large domestic consumption of coal to provide for, so that markets seem to be assured for the products of the collieries.

LAMP HOUSE INTERIOR, MICHEL COLLIERY.
500 Wolf Safety Magnetic Lock Lamps.

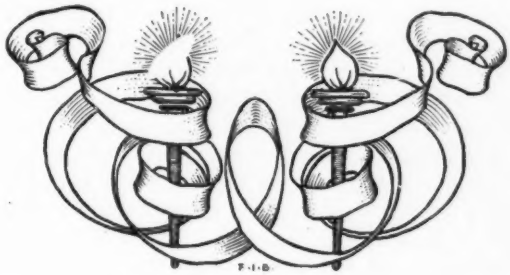
As to cost of coal and coke:—legislative restrictions prevent the Crow's Nest Pass Coal Company from charging more than $2 per ton for "run of mine" coal at the mines, so this will doubtless be the maximum charge, while competition may later bring the price lower. Coke is supplied at $4.25 to $4.50 f. o. b., and freight to Boundary points is $2 to $2.25, so about $6.50 per ton is the cost delivered at the Boundary smelters. Coke from Vancouver Island collieries used to cost $11 delivered at Nelson; now the smelter there gets its coke from the Crow's Nest collieries at a cost not exceeding $6 delivered, so the beneficial influence of the Crow's Nest Pass coalfields has been unmistakably demonstrated by this reduction of nearly 50 per cent. It may be that even lower prices will eventually prevail, for Mr. Wm. Blakemore, M. E., who in 1898 was general manager for the Crow's Nest Pass Coal Company and has since kept in touch with the coal and coke industries of the mainland of British Columbia, writing on this subject in 1902, made these assertions:—

> "At the moment the charge for coal is $2 at the mines, and for coke $4 at the ovens. Effective competition would reduce these figures to $1.50 and $3 and possibly a little lower. The actual cost of shipping one ton of coal need not exceed $1, and will almost certainly be less after allowing for every item of charge. This would give coke at a cost of $2.25 to $2.50, and leave a margin of 50 cents profit on coal and 75 cents on coke, which is at least double the average rate of profit on coal and coke in the Eastern States or in England over the last twenty years."

The managing director of the Crow's Nest Pass Coal Company, when addressing a general meeting of shareholders, told quite a different story, though, and the price of coke was raised from $4 to $4.25 and $4.50.

So far the operations and output of the Crow's Nest Pass collieries have been small in comparison with those of the older coal mines of the United States. Compared with Pennsylvania's output of bituminous coal in* 1902 of 98,947,117 tons, the tonnage of the Crow's Nest, and indeed of the whole of British Columbia, is very small, but for the latter these are the days of small things. Rapid developments and big strides in the march of progress may, however, be confidently looked for, so that by the time these new fields shall have been as long under development as those of the coal-mining State referred to a very different showing will, doubtless, be made.

* We are indebted to Mr. F. E. Saward for information that the bituminous-coal output of Pennsylvania for 1903 was about 105,000,000 tons.—THE EDITORS.



THE HYDRO-ELECTRIC STATIONS OF THE ALTA-ITALIA COMPANY.

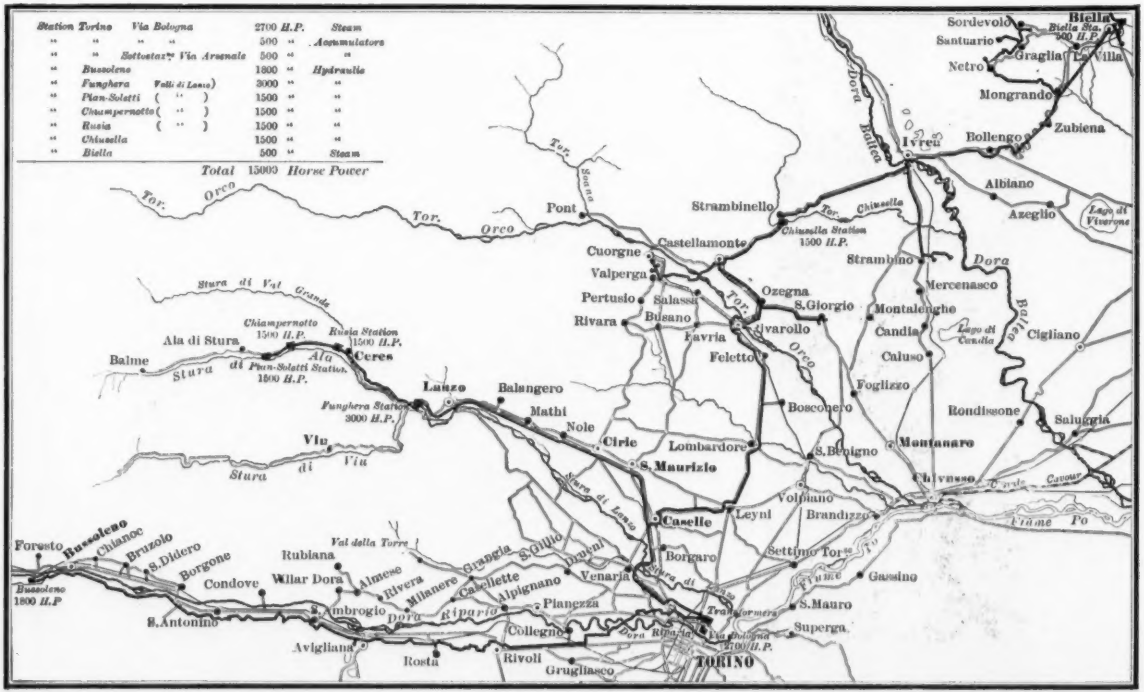
By Enrico Bignami.

AMONG the many important electric enterprises of Italy, one of the most noteworthy is that of the Societá Anonima Elettricita Alta Italia, of Turin, which distributes electric power in Turin for public and private lighting service, for motor installations, and for several tramway lines; and for similar purposes (except as to tramway operation) in many other municipalities within the radius of its distribution network, extending even as far as the town of Biella. The power is generated in the stations of Bussoleno, in the valley of Susa, and of Funghera, in the valley of Lanzo. Three other stations on the Stura between Ceres and Ala supplement the Funghera plant.

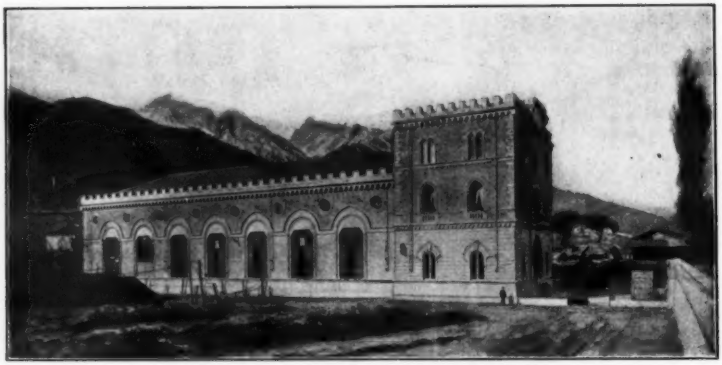
High-tension aerial lines of considerable length carry the power to Turin, that from Bussoleno being about 58.5 kilometres long and that from Funghera about 36 kilometres.

Another large station for the conversion of hydraulic into electric power exists in Piedmont, at a point on the Chiusella called "Ponte dei Preti," near Castellamonte. This station, which also belongs to the Alta Italia Company, supplies light and power to the towns of Biella, Strambino, Cuorgnè, Rivarolo, San Giorgio, and others. The distribution lines from this station to the various points of utilisation, together with the connecting lines from the Bussoleno and Lanzo stations, form a large and very interesting network.

The Bussoleno station is in the valley of Susa, about three kilometres above Bussoleno, on the right bank of the Dora Riparia. From this stream about 6 cubic metres per second are taken, and conducted to the power station through a canal 4 kilometres long and of interesting construction. The difference of level between head race and tail race is 27 metres; from the charging basin the water is taken to the feed pipes of the turbines through two penstocks, each 1.5 metres in diameter and 325 metres long. The turbines—which are installed in a building of great size and very handsome finish—are five in number; three are of 750 horse power each, and two of 120 horse power; they are all provided with oil servomotors for regulation. Each of the three principal turbines is connected by a flexible coupling, to a



SKETCH MAP SHOWING THE HYDRO-ELECTRIC STATIONS AND TRANSMISSION LINES OF THE ALTA ITALIA COMPANY.



EXTERIOR OF THE BUSSOLENO POWER STATION.

690-kilowatt three-phase alternator of 150 revolutions, 50 periods, with a tension of 450 volts between the phases. One of these groups is held in reserve. The two smaller turbines each drive directly an exciting dynamo of 75 kilowatts at 120 volts, 470 revolutions. Either one of these alone is sufficient for exciting the alternators and lighting the building, the other serving as a reserve.

The current is taken from the alternators to the distribution switchboard, placed at one end of the room on a platform from which the whole plant can be conveniently overlooked. On the front of this board, handsomely panelled in wood, are placed the circuit breakers and the measuring apparatus—wattmeters, amperemeters, voltmeters, and the phase regulators. In this installation, as in other large plants erected by Siemens & Halske, provision is made for controlling the turbine regulators from the switchboard, so that the number of revolutions may be so adjusted as to bring the alternators in parallel and divide the load between them equally or otherwise, as may be desired.

Upon the post which carries the governor arms there is mounted a small direct-current motor, which by means of a bevel-gear transmission and worm gearing shifts the fulcrum of the springs which oppose the action of the governor upon the lever controlling the auxiliary motor, thus enabling the constant of the governor to be varied. Each small motor has independent connections to the switchboard, where special switches are provided, the normal position of these switches holding the circuits open, so that the motors remain at rest. When it is found necessary to shift the springs which act upon the governor lever, the proper switch is moved to one side or the other, and a corresponding motion is given to the small motor.

From the bus bars on which it is collected, the 450-volt current is taken to the step-up transformers. The transformer battery is placed behind the switchboard, and consists of seven three-phase transformers, each of 200-kilowatts capacity, and with a transforming ratio of 450:12,000. Cooling of the transformers is effected by simple natural ventilation. The transmission line however does not now lead directly from the 12,000-volt bars; between are interposed the windings of special transformers, to be referred to more particularly further on, by which the tension is raised to 22,000-24,000 volts.

The switches for the 12,000-volt current are very interesting. They are of the piston type, in which there are two double contacts in series at each pole. Each of these double contacts is composed of two contacts in parallel, of which one (with a large surface) is first broken, without forming an arc; the other contact is broken only after the opening of the first has become sufficiently great, and its point is drawn through a tube of incombustible insulating material, in which the arc cannot follow, the arc being moreover blown out and extinguished by the ascending current of air which its own heat produces in the tube.

BUSSOLENO POWER STATION, INTERIOR.

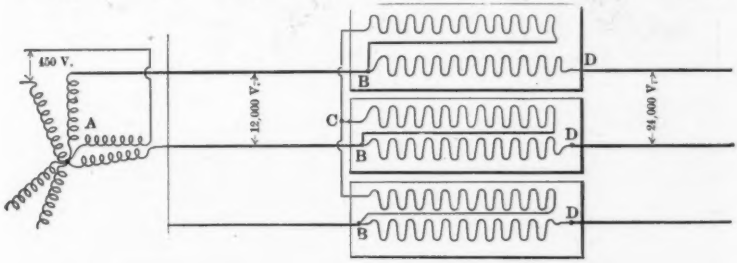
From the continuous-current bars supplying the exciters are taken also connections leading from the power station to two motors installed at the charging basin, at the head of the penstocks. These operate gates shutting off the two halves into which the basin is divided, and thus permit the water to be shut off from either or both the divisions of the penstock. The switch controlling these motors is placed on the distributing switchboard. Other small continuous-current motors operate the oil pump for the servomotors, and various machine tools. In connection with the continuous-current bars there is an accumulator battery of 270-ampere-hours capacity. It is used particularly for the incandescent lighting system by which the installation is served.

The current generated at Bussoleno is almost all transmitted to Turin, a few horse power only being taken off for the dynamite factory at Avigliano. It is first transformed to 3,000 volts in a special station; then, in conjunction with the current brought from Lanzo, it is used either for driving the motor-dynamos in the Via Bologna station, where it is transformed into continuous current for the tramway and lighting service in the central part of the city, or, after a second transformation to 120 volts, it is distributed for light and power purposes in the outlying districts.

Turin's demands for electric power being constantly on the increase, the Alta Italia Company decided to enlarge its stations. To the plant at Funghera, near Lanzo, already mentioned, were added three power houses of 1,500 horse power each, utilising the falls of Stura and Ala, between these villages and Ceres. The power supply will be further increased by enlarging the canal at the Bussoleno station so that the power of the large turbines and their connected alternators will be increased to 900 horse power each. The manufacturers have interposed no objection whatever to the disposal, and trials have shown its entire feasibility. In furtherance of this policy of expansion, the Alta Italia Company recognised the necessity of raising the tension of the transmission, so as to avoid the addition of more lines to those already existing—something which would have been expensive to accomplish. The transmission from Bussoleno to Turin will be brought up to 1,800 horse power, and that from Funghera to 6,500 horse power when the Ceres stations are in full operation.

When it became apparent that the tension of the transmission must be increased, preliminary trials were made by doubling the voltage on the Bussoleno installation. New special transformers (now in successful operation for several months) were added to those first in-

stalled. The increased tension was obtained without any interference with the operation of the 12,000-volt plant. The 450-volt generators and the 12,000-volt transformers were not disturbed; but the 12,000-volt current, instead of being charged directly upon the line, passes first through the special transformers already alluded to. These are three in number, of 600 kilowatts each, monophase, oil-immersed, and constructed for a transforming ratio of 1 : 1. One of the windings is put in series with the line; the other winding is star-connected at one end to the corresponding circuit of the other transformers, and at the other end is connected with the 12,000-volt line. The arrangement is explained by the diagram. The current from the old transformers,

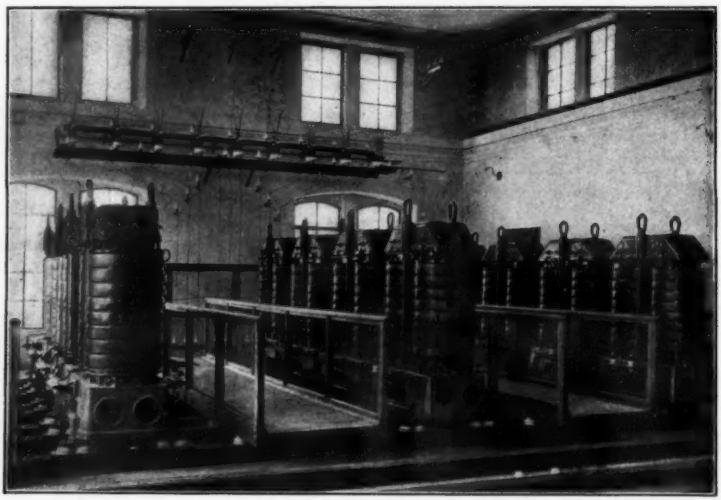


DIAGRAMMATIC REPRESENTATION OF THE BUSSOLENO AUXILIARY TRANSFORMERS.

A, when it reaches the terminals B, divides into two parts. One of these follows the circuits BC, the other the circuits BD. The former may be considered as forming the primary of a transformer in shunt with the line, the latter as constituting the secondary winding. Between the terminals B, D, of the latter there will be induced a difference of tension which is to that of the winding BC as 1:1. But A, the centre of the star of the old transformers, is already at a tension of 12,000 :$\sqrt{3}$; D therefore will have a tension of 12,000: $\sqrt{3}$ + 12,000: $\sqrt{3}$, and the united tension between the two wires will be 24,000 volts.

The transmission line to Turin, as already stated, is about 58 kilometres long. It is supported on wooden poles, into which are screwed iron pins carrying the insulators. These latter, designed for a tension of 12,000 volts, were not considered safe for 24,000 and it was decided to replace them with others. Careful attention was given to the choice, and after tests the "Karlsbader Kaolin Industrie Gesellschaft" type were adopted. These are made of three petticoats superposed, but separately fired, before they are united in one piece, with the same enamel inside and out, so that in each insulator there are six coats of enamel.

At Turin the current is again transformed to 12,000 volts, by transformers similar to those at Bussoleno, just described, but so modified in arrangement and so wound that the electromotive force of the induced current is in opposition to that of the line and the voltage is reduced to 12,000. It is then further reduced to 3,000 volts by the transformers of the old installation, and finally to 120 volts and converted into direct current.



TRANSFORMER STATION, TURIN.

The proved success of the method as shown at Bussoleno determined the adoption of the same plan at the Lanzo plant, and the change is just about completed. All the electric appliances and machinery have been supplied by Siemens & Halske, and the turbines and governors by Riva, Monneret & Co., of Milan.

The Ceres Plant.—On the Stura de Ala, between Ala and Ceres, hydraulic power to the extent of about 4,500 horse power is now utilised. It is obtained from a fall of a total height of 315 metres, divided into three cataracts of approximately equal height. Covered canals having a combined length of 7 kilometres convey the water from the intake on the river, just below Ala, to the first of the power stations —Piansoletti—and thence in turn to each of the others—Chiampernotto and Rusià—finally discharging it into the river below the last station. The three plants are all on the right bank of the river and all alike, both as to the buildings and the mechanical equipment.

The view of the Chiampernotto station shows their general character, and the engraving on page 66 the turbine and electrical installation. Each of the installations comprises three turbines of 750 horse power at 375 revolutions and two of 75 horse power at 600 revolutions, all being by Riva, Monneret & Co. To each of the larger turbines is direct-connected a three-phase alternator capable of developing 700 kilowatts at 13,250 volts. These alternators are noteworthy not only for their high peripheral speed (38 metres per second) and for the high tension attained in a power unit of moderate size, but further for their constructive details; the ventilation is especially good. One alternator in each station is in reserve. For excitation there are in each plant two four-pole dynamos of 50 kilowatts at 110 volts, direct-coupled to small turbines.

THE CHIAMPERNOTTO STATION, CERES HYDRO-ELECTRIC INSTALLATION.

The switchboard is placed on a platform at the end of the building. Underneath this are the high-tension bus bars, to which lead the cables from the alternators. Here also are the safety fuses, the piston-type switches, and the transformers for the measuring apparatus. This is placed on the front of the switchboard, where, thanks to the arrangement of the connections, it is quite away from the high-tension circuits. The circuit breakers placed below the switchboard, and the

rheostats behind it, are controlled from the front by rods. The general arrangement is shown by the illustration on page 67. The entire plan and the construction are simple in the extreme, so that the installations appear rather to contrast in some respects with the other stations of the Alta Italia Company.

From each of the Ceres stations a three-wire transmission line leads to the Funghera plant, with which they will be operated in parallel. Then the total power output—about 7,500 horse—is to be transformed there to 24,000 volts by the method already described as in use at Bussoleno, and transmitted to Turin over the already existing line. This consists of six wires, carried on iron poles spaced 75 metres apart. The lines between the Ceres stations and Funghera are supported on wooden poles treated in part with corrosive sublimate and in part with copper sulphate. They were imported from Switzerland and Germany. The poles are not sunk in the ground, but are supported a few centimetres above the surface by iron stands, set in cement.

THE TURBINES AND ALTERNATORS IN THE CERES STATION.

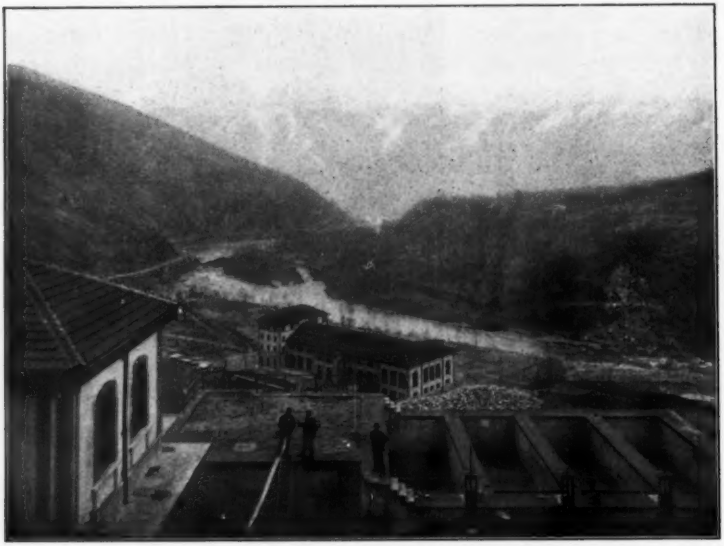
In order to render each station independent of those up-stream from it, by-pass flumes are provided through which the water may be turned when, for any reason, the turbines of a station are not in operation. These flumes have been the subject of special study. It will be

readily understood that to carry the water from one head race to the other, with a fall of 100 metres down a steep bluff between, is a matter of some difficulty. The overflow flumes were made square in section, of concrete-steel, covered, and carried across the face of the escarpment; the slope was broken by basins large enough and deep enough to cushion the force and check the speed of the water rushing down the intervening descents.

GENERAL ARRANGEMENT OF THE SWITCHBOARD.

The Funghera Power Station.—This plant is situated in the valley near Lanzo, and utilises 3,000 horse power obtained by drawing water from the Stura a little above Pessinetto. A canal, about 4 kilometres long, open for the greater part, gives an effective head of 63 metres. From the charging basin the water is led to the turbine station through two penstocks, 1.50 metres in diameter and 200 metres long. Here it drives three Riva-Monneret turbines of 1,000 horse power each at 200 revolutions, coupled to Siemens & Halske alternators of 950 kilowatts each at 3,000 volts, and two smaller turbines of 75 horse power each at 660 revolutions for the exciters. Cables from the alternators lead to the switchboard at the end of the station and thence to the "death chamber" above which is the transformer battery for raising the voltage to 12,000, at which it was originally designed to effect the transmission to Turin. This battery consists of twelve single-phase transformers of 300-kilowatts capacity each, star-connected in threes so as to form three-phase groups of 900-kilowatts capacity. To facilitate cooling, a motor-driven ventilating fan is placed at the base of each. This causes a circulation of air between the windings and between

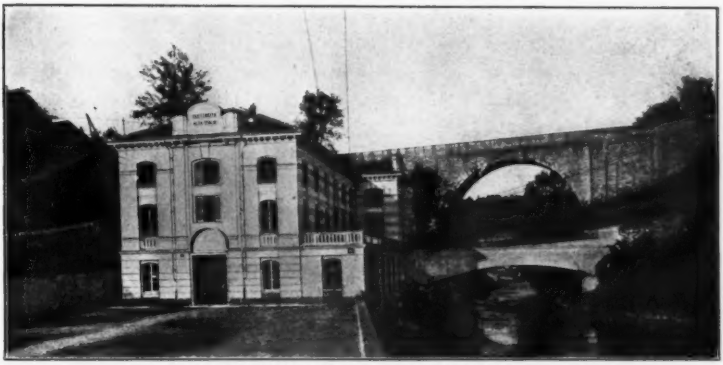
these and the core, which is cross-shaped in section, so that between it and the circular coils there are channels through which the air passes freely. The same raising transformers described as in use at Bussoleno will increase the voltage of the transmission to 24,000. The general arrangement of the station is similar to the others. In it also are installed small motors, controlled from the switchboard, for operating the turbine regulators, and an accumulator battery for reserve in the lighting of the station.



THE FUNGHERA STATION.

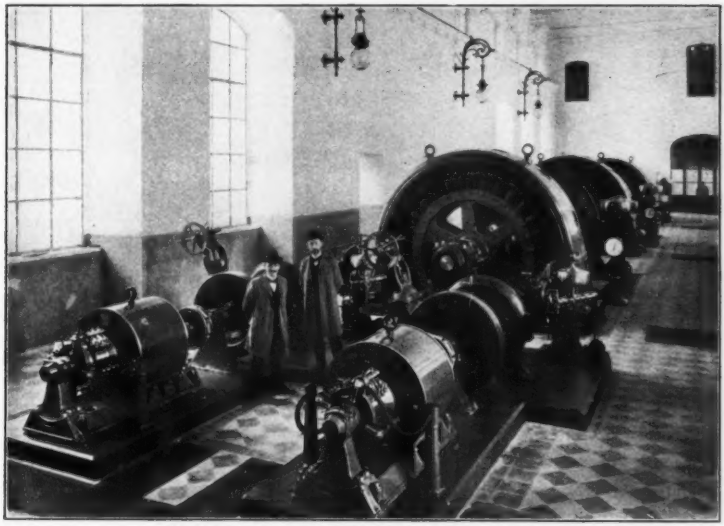
To sum up:—the entire enterprise includes the power houses of Bussoleno (1,800 horse power); Funghera, (3,000 horse power); Piansoletti, Chiampernotto, and Rusià (1,500 horse power each)—a total of 9,300 horse power. The main transmissions—Bussoleno-Turin and Funghera-Turin—are to be at 24,000 volts; the branch lines from the Ceres stations to Funghera, at 13,000 volts.

The Ponte dei Preti Power Station.—The Chiusella torrent, descending the valley of the same name (in which is the mining town of Traversella), just before debouching into the plain, makes a long detour around a spur of the mountains and is broken into many rapids and cascades. By means of a dike, 1,450 litres per second are taken from the river and conveyed in a flume, entirely in tunnel, through

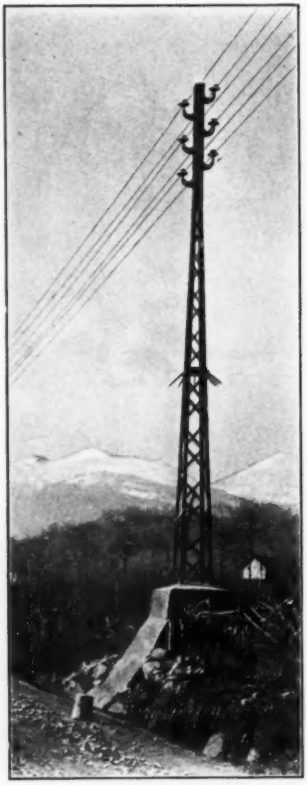


THE PONTE DEI PRETI STATION.

the spur around which the stream flows. The flume, 570 metres in length, delivers the water to a charging basin from which it descends by two steel penstocks, 1 metre in diameter and 1.7 metres apart, to the power station. The penstocks are 510 metres long, completely buried in the ground, and at the lower end cross the stream on a concrete-steel bridge to the power plant. This is on the right bank, just below the characteristic "Ponte dei Preti" (Priest's Bridge) on the road from Castellamonte to Ivrea. The effective head is 120 metres.



INTERIOR OF THE FUNGHERA POWER STATION.

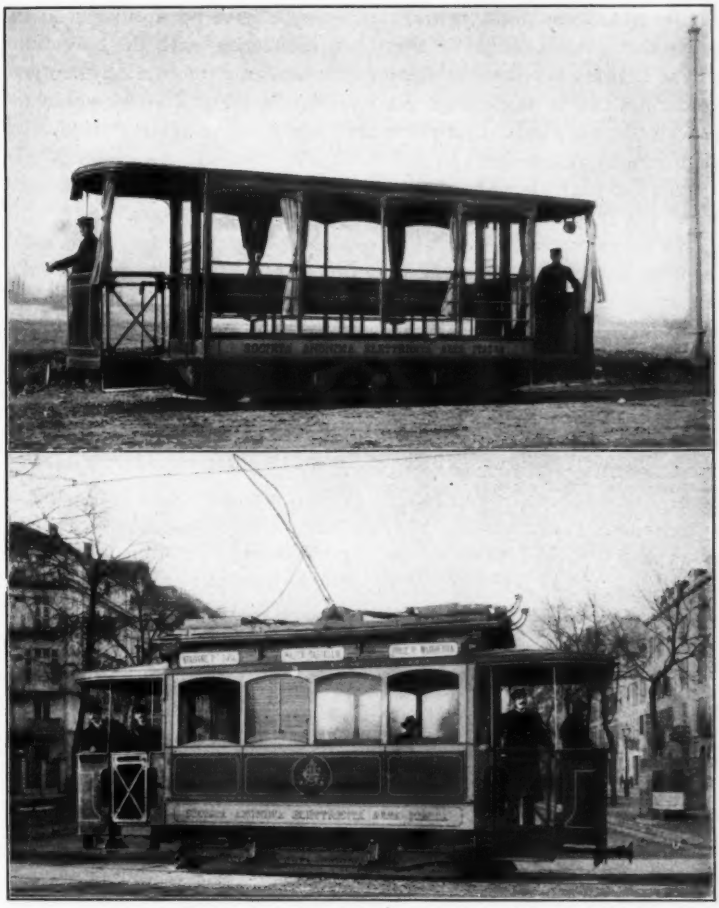


TURIN-LANZO TRANSMISSION LINE.

The station contains five turbines —three of 750 horse power each coupled to 640-kilowatt 440-volt alternators, and two smaller machines for the exciter dynamos. One of the large groups and one of the small sets are reserve. The general disposition is like that at Bussoleno. The 440-volt current goes to the switchboard and then to the transformers. These are seven in number, three-phase, and of a capacity of 200 kilowatts each, with a transforming ratio of 440 : 11,000. As in the other installations, they are placed on a platform behind the switchboard, and below them is the high-tension apparatus.

Small direct-current motors operate the turbine regulators; other direct-current motors drive the oil pump for the servomotors of the turbines, and the air compressor for the maintenance of the air chamber at the foot of the high-pressure penstocks; others still drive machine tools, and move the gates at the head of the penstocks.

Three high-tension lines are carried from the station. One, passing close to Ivrea, goes to Biella, 34.5 kilometres away; a branch leaves this line at Mongrando and carries the current to Sordevolo and Graglia. A second line leads to Strambino. The third divides into three branches, one supplying Valperga and Cuorgnè, another Ozegna and San Giorgia, and the third joining near Caselle the line from Lanzo to Turin. Normally, however, the switch between the lines is not closed, for the tension on the Lanzo-Turin circuit is somewhat higher than that on the Rivarolo-Caselle line. But in winter, when the water is low and the Ponte dei Preti plant is insufficient for the demands made upon it, the Rivarolo-Caselle circuit is cut out and connected with the Lanzo plant, while the Ponte dei Preti power is all used in the Biella circuit, and if necessary supplemented by that from the reserve steam-



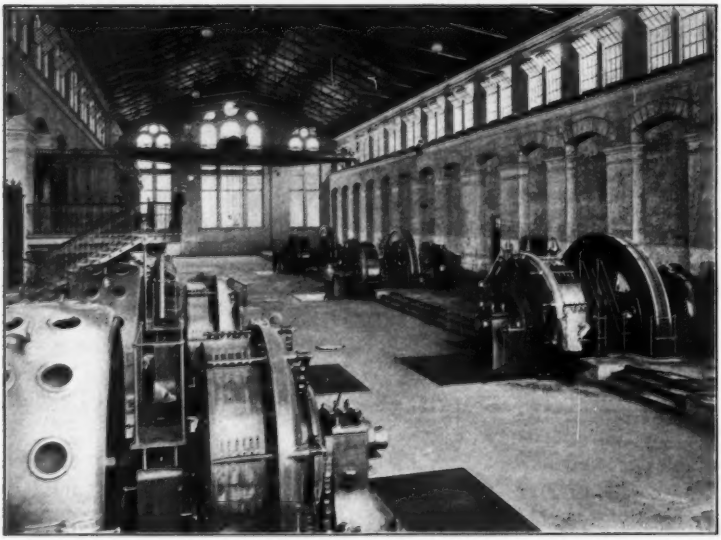
MOTOR CAR AND TRAILER, ALTA ITALIA COMPANY'S TRAMWAY.

power station at Biella. To enable the operation of the Ponte dei Preti and the Lanzo stations in parallel, it is designed to introduce a transformer like those at Bussoleno, so that the tension of the Lanzo current may be reduced a few hundred volts and made the same as that from the Ponte dei Preti installation. The distribution is effected in the form of three-phase current at 120 volts for lighting and for small motors, and at 500 volts for larger motors. At Cuorgnè, San Giorgio, Valperga, and Graglia special Siemens & Halske regulators

of the Bussoleno auxiliary-transformer type have been introduced to prevent the variations in tension from interfering with the operation of the lighting service. In these regulators an induced electromotive force in a coil in shunt with the line may be added to or opposed to that of the line itself. Elsewhere the tension of the lighting circuits is regulated by resistances.

All the lines are carried on wooden poles into which are screwed iron pins supporting the insulators. Upon these, especially in front of the transformers, are Siemens & Halske horn lightning arresters.

The Biella Power Station.—At Biella the current from the Ponte dei Preti installation is in part distributed to large motors, provided with their own transformers, in part transformed to 500 volts for a circuit supplying smaller motors, and in part converted into direct current for electric lighting. Altogether, there were recently in use motors aggregating 400 horse power. The conversion into direct current is accomplished in the Santa Marta station. Here two transformers of 150 kilowatts each reduce the tension to 500 volts; the current then passes to two motor-generators, each consisting of a three-phase synchronous motor making 750 revolutions, direct-coupled to a 100-kilowatt four-pole dynamo wound for a tension of 220 volts, which can be pushed up to 300 volts. The variable tension is to facilitate the



INTERIOR OF THE TURIN GENERATOR STATION.

charging of the accumulator batteries, of which there are two in series, each composed of 130 elements, and of a capacity of 900 ampere-hours for a three-hour discharge. The two direct-current dynamos are connected in series with the terminals of the batteries, and the neutral wire of the distributing network is connected to the central point; the maintenance of a uniform tension of 220 volts on the lighting circuits, with a variable voltage in the charging dynamos, is effected by the insertion of two double transformers. Excepting one feeder line composed of two cables, the entire distributing network is aerial.

As a reserve to the hydraulic installation, and especially to supply any deficiency during the winter period of low water, a steam power plant has been installed upon the banks of the Cevro, a stream, flowing through Biella. It is equipped with a battery of boilers carrying 13 atmospheres, with economisers and superheaters; the engine is a tandem compound by Franco Tosi, of 500 horse power, direct connected to an alternator of about 500 kilowatts at 125 revolutions. The tension is 500-550 volts; it may be raised by three 170-kilowatt three-phase transformers of 9,500 volts, the tension at which the current from Ponte dei Preti reaches Biella. Normally, however, the steam-driven alternators are connected with the 500-volt three-phase circuits from the Santa Marta station, which they thus reinforce. A 23-kilowatt 220-volt exciter is provided in this station; it is so arranged, however, that if desired the alternator may be excited by current from the Santa Marta station.

The Turin Stations.—These are two in number—a transformer and a generator station. Of the former description has already been given. The generating station contains six tubular boilers, and three horizontal steam engines of 900 horse power each, direct-connected to 600-kilowatt dynamos. The other machinery in the station consists of rotary converters, auxiliary sets for charging the accumulators, a storage battery of 300 Pollak cells, and (in the sub-station) another storage battery, auxiliary charging sets, and boosters.

As already stated, the Alta Italia Company furnishes electric power not only to private consumers, for light and power, but also to several lines of tramway of which it is concessionaire. Originally these were operated on the mixed system—that is, trolley in the suburbs and storage battery in the centre of the city; but storage-battery operation was so burdensome to the company that in order to secure consent from the municipality to the general adoption of the trolley, the company paid a considerable gross sum to the corporation and gave it a larger interest in the receipts of further operation.

GENERAL VIEW OF THE INTERNATIONAL AUTOMOBILE EXPOSITION, PARIS, 1903.

THE INTERNATIONAL AUTOMOBILE EXPOSITION AT PARIS.

By Lucien Perissé.

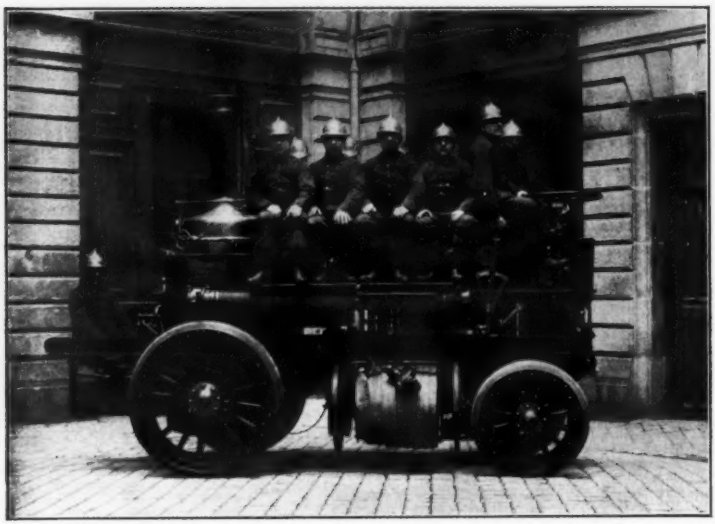
France has taken a notable part in the development of the automobile, and M. Perissé in his technical work has been closely associated with this development. He summarizes in this article the most salient mechanical features of the recent Exhibition in Paris.—THE EDITORS.

THE President of the French Republic inaugurated, on the 10th December last, the sixth exposition organised by the Automobile Club of France at the Grand Palais of the Champs Elysées at Paris.

By its splendor and the number of exhibitors, the success of this exposition far surpassed that of former expositions, and the photograph gives but a faint idea of the wonderful whole.

All the stands of the exhibitors were very well decorated, and almost all were lit up at night by garlands of many colored electric lamps, thus contributing to the success of the fairy spectacle which M. Gustave Rives, the celebrated architect of the Automobile Club of France and general manager of the exposition, put before the visitors. M. Rives pushed his boldness in the art of decoration to the point of bespangling, like a starlit sky, the immense hall of the Grand Palais with from thirty thousand to forty thousand electric lamps shaded in yellow. At the highest point of the central dome, 60 metres high, the arrangement of these lamps along the iron work of the metallic framework formed an immense sun, which, at nightfall, sprang into light with a single touch. The marvellous lighting thus effected allowed the general manager to keep the exposition open until ten o'clock at night, inducing visitors to come from all the extremities of the capital, for the immense Palais seemed to be, during the evening, a gigantic lantern, reddening the sky as if by a tremendous conflagration. The whole of the Avenue Nicholas II and the façade and approaches to the Palais were also illuminated; the organiser installed about 60,000 lamps in the course of a few days.

On the opening day more than forty thousand persons were admitted, not without difficulty, into the exposition, and the crowd of people there about four o'clock in the afternoon was such that it was



AUTOMOBILE FIRE ENGINE OF THE PARIS FIRE DEPARTMENT.

necessary several times to close the doors. These figures are eloquent, and speak for themselves as to the number of partisans and admirers which the automobile industry has in France.

The central part of the Grand Palais was occupied by the carriage builders, the adjacent galleries by the builders of bodies and the wheel and pneumatic-tire makers, while the first story was reserved for the makers of accessories and of wearing apparel for the sport. Lastly, a large space was given up this year to the builders of automobile boats.

The success of the exposition was endorsed by the presence of numerous foreign visitors and also by the interesting exhibits from foreign manufactories of automobile constructions. Side by side with the celebrated German Mercédès, winner of the Gordon-Bennett cup, must be mentioned the Italian automobile works of Turin, the Spyker factories of Amsterdam, several English and Belgian makers, and, as representative of the United States of America, the celebrated Oldsmobile carriages, of a style very original and very different from European carriages.

Several interesting novelties must be singled out:

1. Bulky Machines, called "Heavy Weights." The city of Paris exhibited a new steam fire-engine automobile constructed by the

Société des Etablissements Weyher et Richemond de Pantin (Seine) for the Régiment des Sapeurs-Pompiers de Paris (Paris Fire Department). This powerful engine, shown in the illustration on page 76, was constructed to fight fires of exceptional violence, and also to aid the towns on the outskirts of Paris, which do not usually possess powerful fire engines. It is entirely complete within itself, for it carries with it its staff of eleven men and its equipment, which latter comprises 600 metres of hose and nine hose-nozzles, two bobbin reels, one hook and ladder, and all necessary accessories, without the necessity of being accompanied by an auxiliary wagon. As in the steamers already in use, the water in the boiler is constantly kept at a temperature of 100 degrees centigrade, which allows the requisite pressure for starting to be obtained in three minutes. The normal speed of the automobile being 24 kilomètres an hour, these three minutes are easily recovered, especially when the distance between the station and the place of the fire is of some length.

The pump can discharge 2,000 litres a minute, and the vertical two-cylinder compound steam engine develops 30 horse power. For starting and for the ascent of the steep gradients, the mechanician can, by means of a simple handle, placed under the steering wheel, turn high-pressure steam directly into both cylinders at a pressure of 10 kilogrammes per square centimetre. Under these conditions, the engine develops more than 40 horse power. The same engine does duty for the traction of the automobile and the working of the pump, and when the vehicle is in motion the driver varies the speed of it simply by the touch of the regulating lever placed at his right hand, by means of which he varies the speed of the steam engine. The same lever serves for reversing, and all this is obtained without the interposition of any other appliance for changing the speed. The driver can very easily steer with his left hand, thanks to a very large steering wheel; he has under his foot a progressive brake acting upon the driving wheels. In addition to this, the chauffeur, who rides at the back, has under his hand a brake which acts upon the differential shaft controlling the pinions and chains which drive the wheels.

Electric and petroleum-driven motors have already been applied in numerous ways to the traction of fire apparatus. But this new automobile steam engine is an improvement, for it allows of rapid transportation in the same vehicle of both the men and implements to fight great fires. It does the greatest credit to its constructor and to Lieutenant-Colonel Vuilguin, the officer who designed it.

The Continuous Propulsion Automobile Train consituted an origi-

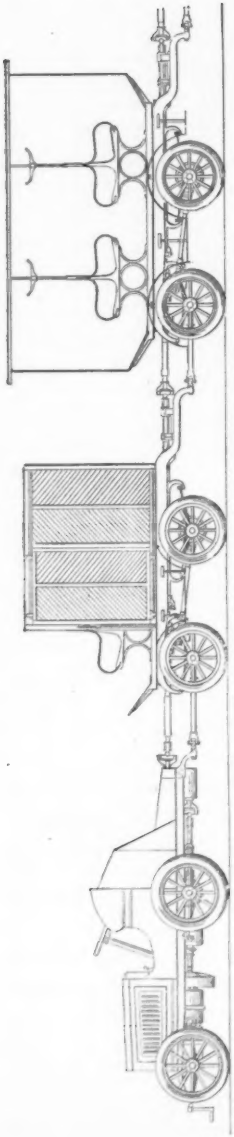


DIAGRAM OF RENARD CONTINUOUS PROPULSION TRAIN.

nal novelty. Its inventor, Colonel Ch. Renard, who constructed in 1885 the first dirigible electric balloon, "La France," designed this train for the transport of the commissariat of the French army. In this instance he employed a steam locomotive, whereas the train exhibited lately consisted of a series of lighter vehicles intended to be coupled behind a petroleum-driven locomotive of 50 horse power.

For several years back French and English constructors have sought to solve the problem of the "Heavy Weights"; that is to say, they have tried to transport loads of several tons either upon single vehicles or upon trains. The former have been employed principally in France; such are the steam trucks of de Dion-Bouton, Turgan-Foy, Purrey, etc.; the latter, with steam road locomotives, have been in especial favour in England. This method of mechanical traction was applied during the Transvaal War. If trucks carrying from 4 to 10 tons of merchandise and weighing, dead weight included, 8 to 16 tons, are employed, the difficulties which are met with, owing to these extra weights being distributed only upon two axle trees, are numerous; but the chief is the speedy deterioration of the roads, especially if the use goes on every day over the same route. This inconvenience is very much increased with the employment of road locomotives, which themselves weigh 15 to 20 tons, when they are required to draw a train of several carriages heavily loaded. In practice, the locomotive should possess in itself the adhesion to the ground necessary for the traction of the total weight of the train, and this adherence, calculated and limited for

traction on the level, becomes altogether insufficient on gradients or upon a slippery surface. Practically speaking a mechanical tractor can only draw, upon a road not entirely level, a train of which the weight is hardly greater than its own. The greatly augmented weight of the tractors and the considerable strain exercised by the driving wheels at the point of contact with the ground are two material causes of the deterioration of the roads, for this strain is, for two wheels only, equal to the tractive resistance of the whole train.

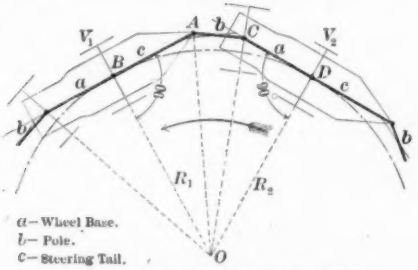
It is to avoid these manifold inconveniences that Colonel Renard has contrived the train with *continuous propulsion.* In this system there is no single tractor. The carriage placed at the head of the train is provided with a motor, the power of which is distributed to all the other carriages by means of a longitudinal articulated shaft, which, extending from one end of the train to the other, drives one pair of wheels in each of the carriages. Each carriage is thus a motor, the foremost serving only to generate the power for the whole train. Under these conditions, the adhesion to the ground is due to the weight of the entire train; it is proportionate to the resistance to be overcome and each carriage moves itself as if it were isolated. The first carriage, called the "locomotor," is not greatly heavier than the rest, thanks to the lightness of the petroleum motor. Moreover, the effort exerted at the rim of the driving wheels is the same as if each carriage were isolated. Consequently, thanks to the employment of carriages lighter than a tractor and to the distribution of force among all the driving wheels of the train, the deterioration of the roads is much diminished.

The articulated shaft is furnished with universal joints and with sundry arrangements which allow the train to follow the most tortuous track and permit of the coupling and uncoupling of carriages at will.

The continuous-propulsion train presents another advantage over the highway trains previously employed. On account of the tendency of carriages to deviate at the turns of the road, from the track of the tractor or of the preceding carriage, it was very difficult, in practice, to steer a train upon a very winding road or around sharp corners above all on gradients, or when the slope of the road surface was considerable. A train of several carriages could not proceed except upon roads almost straight, almost level, and of which the serviceable width of causeway served to counterbalance, without inconvenience, the curvature. Colonel Renard applied to his train the principle called "accurate turning," by means of a special arrangement of the coupling of the carriages called "steering coupling." The accurate turning causes all

the carriages of the train to follow precisely the circle described by the first carriage, whatever may be its radius, and the arrangements devised by Colonel Renard apply as well to the ordinary front running gear of horse vehicles as to the front gear with two pivots employed in automobile vehicles.

The inventor has succeeded in solving the problem by a geometrical

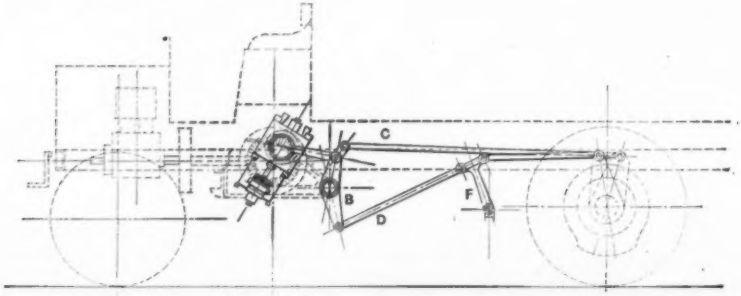


THE RENARD TRAIN STEERING GEAR.

The steering tail *c* at the rear of each car turns the pole *b* of the next car and sets the wheels. Using the Ackermann gear the cars follow each other so accurately that the entire train makes but a single pair of ruts in sand.

combination of the elements of coupling and steering. These three elements are *l'empattement* (the wheel base), *le longueur du timon* (the length of the carriage pole), and *la queue* (the tail piece).

The wheel base is the distance which separates the two axles of a carriage; the length of the carriage pole is measured from the front axle to the point of articulation with the preceding carriage; and the tail piece is the distance from the rear axle to the point of articulation with the carriage following. These three lengths being suitably chosen, all the carriages will follow exactly the track of the locomotor in front without deviating more than 30 centimetres under the most unfavourable circumstances.



DRIVING MECHANISM OF THE HAGEN AUTOMOBILE TRUCK.

The driver upon the locomotor drives the train with ease. In fact, his sole concern, as in all single automobiles, is with the steering, changes of speed, and braking. If he steers the locomotor properly, he is sure that the carriages of the train will follow his track with precision. The change-of-speed apparatus is of the ordinary description; and, moreover, a special appliance called *variator* has the effect of reducing in a determined proportion the speed of the train without interfering with the ordinary change-of-speed apparatus. In practice, when the locomotor is isolated, the variator is put in its first position and the change of speed allows the locomotor speeds of 16 to 72 kilometres an hour. If it is followed by 8 to 10 carriages, the variator is fixed for a low speed and this ranges from 4 to 18 kilo-

HAGEN AUTOMOBILE TRUCK, WITH PETROLEUM MOTORS.
Weight, 3,060 kilogrammes; load, 5,390 kilogrammes; 12 horse power.

metres an hour. It is therefore easy to enumerate the many applications of so adjustable an apparatus, for the quick transport of merchandise in any public service or in any industrial enterprise. Finally, the braking upon the longitudinal shaft which transmits the power affects all the vehicles in the same degree, and thus provides a continuous brake.

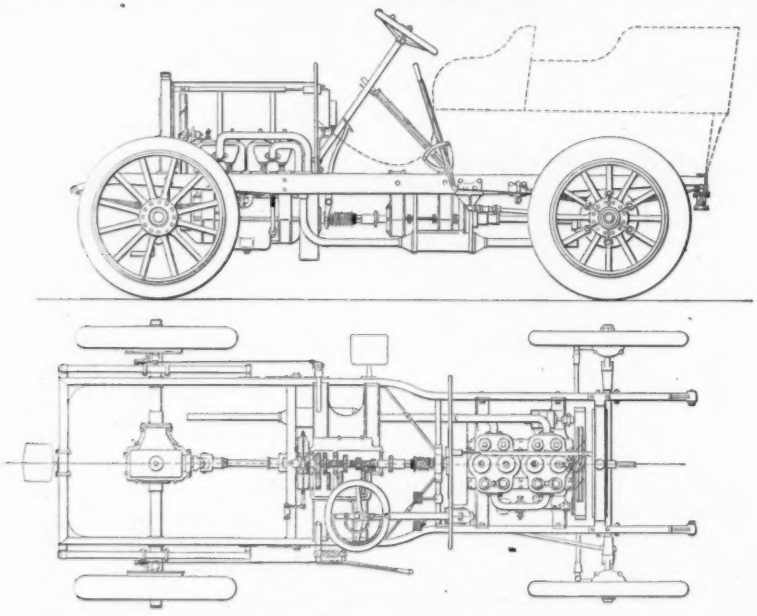
The advantages of the automobile road train, Renard system, over the ordinary road train or the heavy-weight load-carrying vehicle, are unquestionable and can be summed up thus:—

Less dead weight and consequently less deterioration of roads; facility of driving the train comparable to that of a single automobile; economy of labor; and wide range adaptation while using a given power, through the ability to vary at will the factors of effort and speed.

Several constructors exhibited truck automobiles capable of carry-

ing several tons of useful load—for example, the petroleum trucks of MM. Desmarais and Morane and those of MM. de Diétrich et Cie., the steam tractors of MM. Turgan-Foy and Mr. Scotte, already tested in past years, and lastly a petroleum-driven truck of peculiar make, exhibited by the French Hagen Automobile Truck Company (Société Français des Camions Automobiles Hagen).

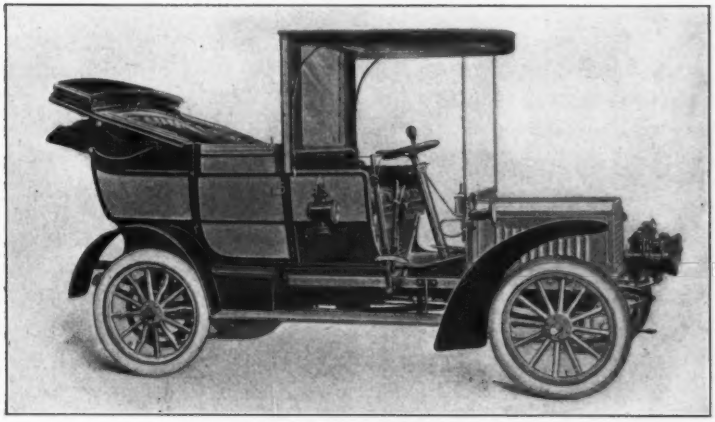
In this the power of the motor is transmitted directly by means of a system of two connecting rods with ratchet gear driving the two rear driving-wheels. This arrangement gives a higher efficiency from the



THE HOTCHKISS AUTOMOBILE CARRIAGE.

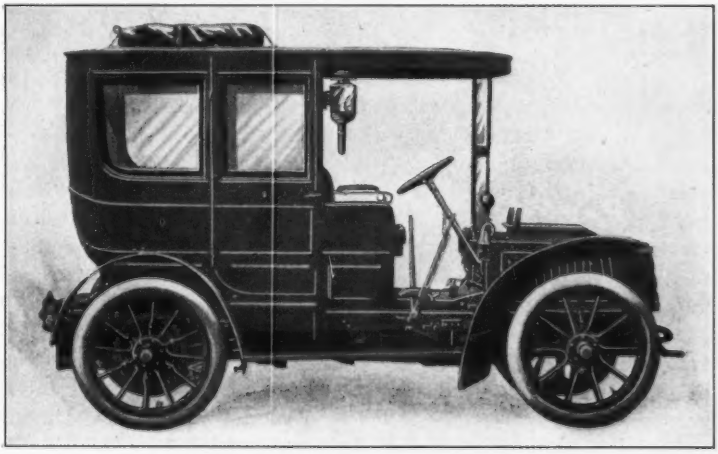
motor and thus appreciably diminishes the consumption of fuel. In addition to this, a special patented arrangement makes it possible to increase or diminish progressively the length of stroke of the levers which operate the ratchet in such a way that instead of having only three or four speeds we pass gradually from the zero speed up to the maximum speed of 14 kilometres without check through all the intermediate speeds. It follows that the power exerted by the motor is always exactly proportioned to the work required.

The rear axle upon which the ratchet is fixed also carries a revers-



LANDAULET, FOUR SPEEDS.

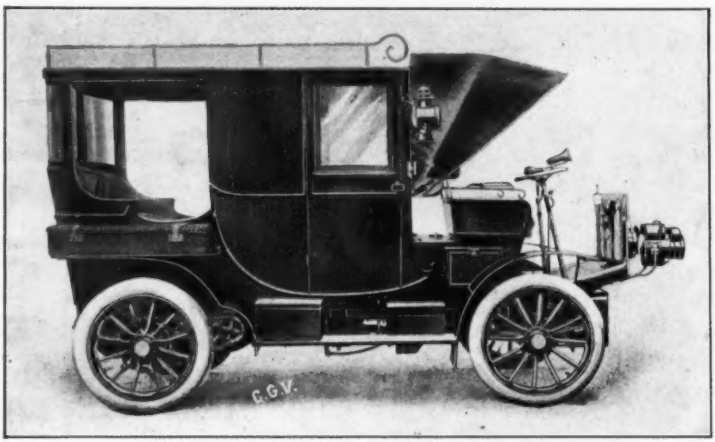
ing gear and a differential by direct gearing, which allows the axle to be made of a single piece—an appreciable advantage in conveyances designed to carry heavy loads. The weight of the Hagen truck when empty is 3,060 kilogrammes; the weight of the useful load, in a recent experiment, was 5,395 kilogrammes, which gave a total weight of 8,455 kilogrammes. In spite of this heavy load, the two-cylinder motors of 12 horse power behaved well, and the economy as determined was satisfactory.



"LIMOUSINE COUPÉ," BY DE DIETRICH & CIE.

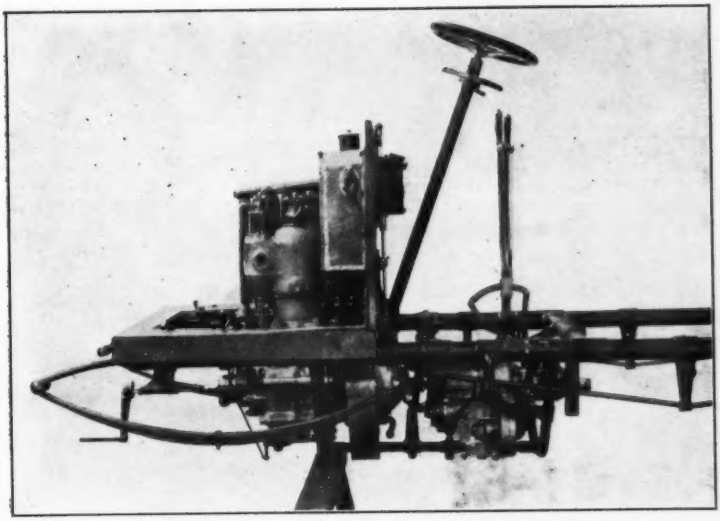
2.—Carriages for Town and Touring.—The number of constructors of these carriages, and the number of carriages exhibited, were so considerable that it would require several numbers of this magazine to review them all.

One new automobile builder exhibited for the first time, and the carriages justly drew the attention of visitors. This was the Hotchkiss gun company, Société Française de Canons Hotchkiss, which turning from the manufacture of cannons, has set itself to the construction of the machinery of peace. The construction of these requires as much care as that of artillery, in the choice of materials and in the manufacture, and this firm has put out as its first product an

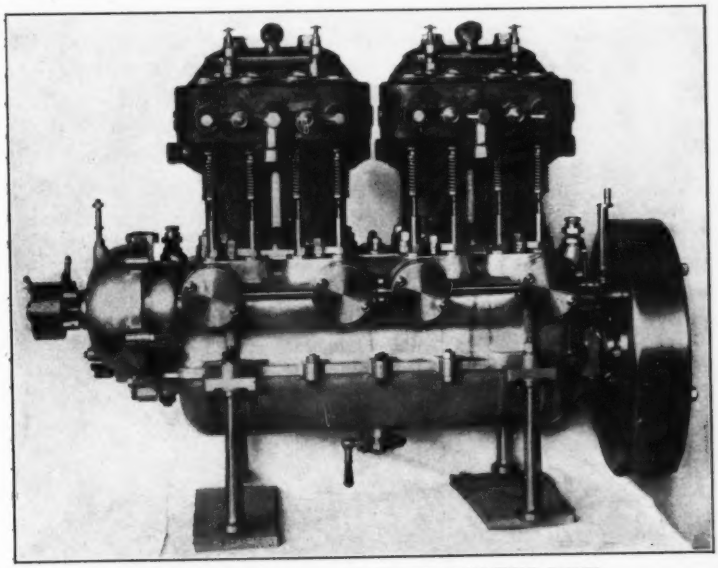


TWENTY-HORSE-POWER BERLINE, CHARRON, GIRARDOT & VOIGT.

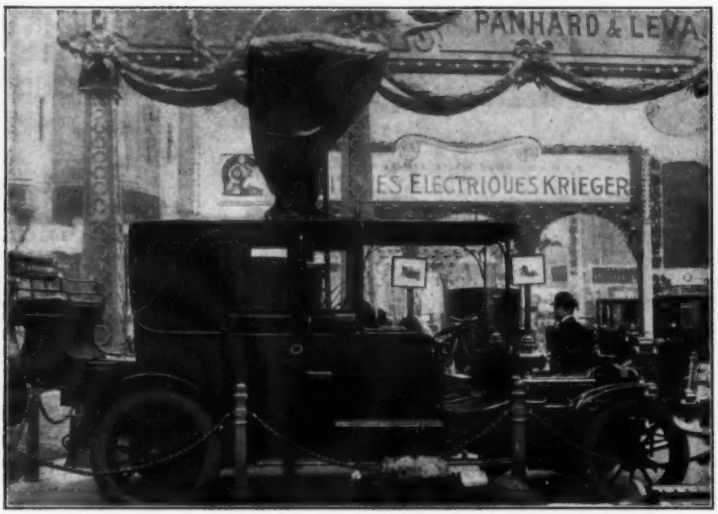
admirable carriage—frame of very light nickel steel, four-cylinder motors, of which the crank shaft (of nickel-chrome steel) turns upon five ball-bearings; valve-motion gearing of vulcanized fibre to deaden the noise; all the speed-changing gear furnished with ball-bearings, and finally a universal joint and a very well designed rear axle, with ball-bearing for both rolling and thrust bearings. MM Spyker Brothers of Amsterdam also exhibited for the first time. Their four-cylinder motor presents a peculiar and original mode of construction. Each cylinder with its valve-chest and water jacket forms a unit, with surfaces so faced and dressed that it may be assembled against the neighbouring cylinder; when all are thus put together the four cylinders and all the valves are cooled by a single water jacket, without any connections by piping. MM Spyker also exhibited a six-cylinder



RENAULT CHASSIS FOR 7-HORSE-POWER MOTOR CARRIAGE.



FOURTEEN-HORSE-POWER RENAULT FOUR-CYLINDER MOTOR.



TOURING BERLINE, BUILT FOR PRINCE ORLOFF BY PANHARD & LEVASSOR.

carriage of 20 horse power, the power being divided between the rear and the front axle, the latter being at the same time the steering axle.

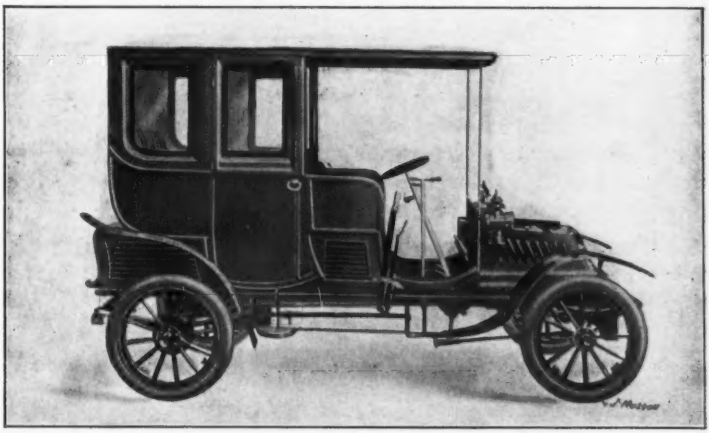
MM Renault Brothers, Parisian builders, the winners of the Paris-Vienna race, showed carriages remarkable for their simple, light, and well-finished construction, of which the annexed photographs give a very exact idea. One of them shows a four-cylinder motor of 14 horse power with all its valves controlled from the same side of the motor. The second shows the front of a chassis with single-cylinder motor of 7 horse power. It is to be noted that the Renault establishment keeps to steel tubes in the construction of its chassis, with reinforcement beneath to increase the rigidity while preserving great lightness. Among other builders there appears a tendency to employ pressed sheet steel for the chassis.

The celebrated firm of Panhard-Levassor, which has gained so many victories, exhibited once more models of three and four-cylinder motors. The three-cylinder model of 1904 is of about 8 horse power, and designed to be small, light and well-balanced; it is meant for light vehicles and town carriages. The four-cylinder motors for power greater than 8-horse, like the three-cylinder motors, are constructed with the cylinders completely isolated from each other. The Panhard-Levassor company has found very great advantage in this construction. As in previous years, they have made their frames of wood with

metal armour, and they are making chassis of considerable length, as is proved by the photograph we give of the great touring berline, seating ten or twelve, which was ordered from them by Prince Orloff. This berline has a wheel base of 3.85 metres, which means that it will not be always easy to make it take the turnings.

A remarkable feature this year is the general improvement in the construction of carriages, but particularly in the construction of chassis. Statistics of 119 chassis exhibited by French builders (chassis stripped, without bodies), show that the chassis in pressed steel were in the proportion of 46 per cent., those of armoured wood 32 per cent., those of steel tubes 14 per cent., and those in steel sections, 7 per cent. This shows that the pressed steel plate has the most advocates in France. This mode of construction allows of the economical manufacture of very long, rigid, and light chassis. The union of false chassis and of cross-bars can be made by rivets. The engine parts, the springs, and the body are attached by bolts, easy to regulate and unfasten, while the chassis of tubes or armoured wood require either collars, soldered or bolted, or screws or nuts, difficult to unfasten or requiring precautions and very great care in fixing; in short, the mounting of chassis of pressed steel is better mechanics. This construction has been specially studied in France by Mr. Arbel, manager of the Douai iron works, known to all engineers for its admirable construction of wheels and railroad wagons.

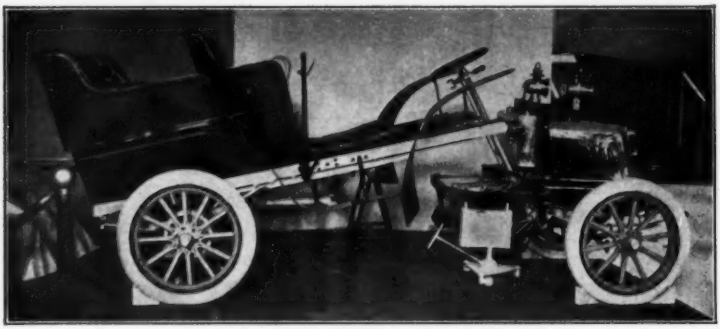
Mr. Arbel had a very interesting exhibit of his principal models, among which were pressed plates of a single piece which reflected the



EIGHT-HORSE-POWER DE DION-BOUTON COUPÉ.

greatest credit on the eminent engineer. These chassis have allowed coach builders to construct bodies of large dimensions, assuring a degree of comfort unknown up to the present day, and constituting styles of carriages for town and travel which are guaranteed to render the greatest service during the winter. Formerly automobiling was a summer sport; it ceases to be merely a sport and becomes an institution of every season of the year. The types of large closed carriages called limousine, coupé, laudaulet, berline, etc., can now all be arranged with entrance at the side, and on both sides, precisely like the comfortable horse carriage so long in use in the large European towns. The illustrations on pages 83, 84, give an exact idea of the present constructions of some of the greatest French coach-builders.

The tendency of the public to demand from constructors closed carriages for city use has forced this construction even upon the small



LACOIN CARRIAGE WITH SEPARABLE CHASSIS.

chassis of the coupés, and the great manufactory of MM. de Dion-Bouton & Cie. showed a coupé (or landaulet) upon chassis of 8 horse power only, which reflected the greatest credit upon its builders. Thanks to a careful attention to all the details and to a very skilful distribution of the various elements of the body upon the chassis, this coupé is set up with a wheel base of 1.90 metres only.

The Exposition showed also some mixed carriages—that is, carriages having a petroleum motor and one or more dynamos, according to the arrangements adopted. In certain cases electricity produced by a generating unit is utilised by motors which drive the wheels of the vehicle. In this system, electrical transmission takes the place of any mechanical medium for transmitting motion. Such is the mixed carriage of the Parisian Company of Electrical Carriages (Cie. Parisienne des Voitures Electriques) Krieger process. In this carriage a powerful

motor is used, as it is not supplemented by accumulators as in the carriages next mentioned.

MM. Mildé & Cie. also employ a generator and motors driving the wheels, combined with a battery of accumulators. The petroleum-essence motor which drives the generating dynamo is of low power.

La Cie. de l'Industrie Electrique et Mécanique (Thury patents) showed a mixed carriage in which a dynamo introduced between the prime mover and the mechanical transmission to the wheels takes the place of a clutch and serves as a speed changer; it is combined with accumulators.

In these two cases the battery of accumulators serves as a regulator according as the effort required is greater or less than the power furnished by the dynamo generator. The battery is charged when running down hill; it furnishes power in an ascent, and aids the prime mover in supplying power to drive the carriage. The advantages afforded by the battery are manifold, but the chief is the possibility of propelling the carriage for a certain distance exclusively with the accumulators, in case of serious damage to the motor *en route*. That might prove to be a valuable assistance.

Two inventors, Mr. Latil and Mr. Albert Colin, exhibited a motor for front running gear, designed to facilitate the mechanical traction of town carriages by the quick and simple substitution of the motor-driven fore-carriage for the fore-carriage with shafts used with horses. This arrangement should find application to public vehicles in large towns and to certain kinds of industrial vehicles.

Mr. Lacoin exhibited an extremely ingenious automobile carriage with detachable chassis. The system consists in mounting a carriage upon two chassis, put together or separated at will in a few minutes. The first is the motor chassis. It comprises the motor, its accessories, speed changes, and the front steering axle. The second, called the "*chassis carrosserie*," supports the body and is mounted upon the rear motor axle.

The two chassis are each of rectangular shape, and the rear one, which is a little wider than the other, is made with prolonged side pieces, like two shafts, on both sides of the motor chassis. At four points of junction of the two chassis a peculiar system of lock-bolting gives rigidity to the whole and prevents all possibility of play. To separate the two chassis all that is required is to unfasten the four lock-bolts and to unfasten the shaft transmitting the motion to the rear axle. For this purpose this shaft is constructed in such a way as to be withdrawn easily by the hand and the shaft of the universal coupling

lies alongside of the rear axle, falling into a collar arranged to hold it. The motor chassis of Mr. Lacoin's carriage is so easily removable that it can be yoked at will to body chassis of different lengths and forms. The system promises to render important services, as for example to a private owner who wishes to have several types of different carriage bodies, or to a livery man who is obliged to have winter and summer vehicles, or further, to a business man who wishes to use the motor as he may desire upon a light carriage or upon a vehicle intended for the carriage of merchandise. Although there would be, in the last case, an important difference of weight, the two combinations are possible and practicable, seeing that it is the body-chassis which supports, with the rear axle, the universal coupling, the change-speed gear by bevel pinions, and the differential, all three being proportioned to the weight and the load of the body. This combination of a motor for several vehicles permits of a quicker reimbursement of the cost of the mechanical part of an automobile carriage, which is the most expensive part.

In surveying the galleries it was especially noteworthy that the efforts of the manufacturers were directed towards attaining the ideal pneumatic tire; that is to say, something which cannot burst, which does not come loose, and yet remains flexible. There is not space here to examine the numerous arrangements made to attain the triple end. Let us note only that the tire protectors of leather, provided with iron head plates, are more numerous than formerly. This would appear to be the solution sought for—the direct iron-sheathing of a tire, extolled for the last two years, having the inconvenience of diminishing the elasticity of the tire.

Among the best known brands of tires for carriages should be cited the Continental, the Dunlop, the Gallus, the Falconnet-Pérodeaud and the Michelin. The Exposition of 1903 contained 458 automobile carriages and consequently 1,832 wheels, 1,400 of which were furnished with tires of this celebrated French brand—that is to say, about 77 per cent. These figures show how merited is its reputation.

The Sixth International Exposition of Automobiles is about to close its doors: let us hope that the exhibitors there have secured many orders, and may thus be encouraged to make that of the coming year still more interesting and sumptuous. The strides of automobilism are so rapid that an annual exposition is necessary, were it only to stimulate the ardor of the inventors and builders, as the races do the speeds.

THE COMPARATIVE EFFICIENCY OF INTERNALLY FIRED AND EXTERNALLY FIRED BOILERS.

By D. W. Robb.

It is generally admitted that theoretically the internally-fired boiler should have a lower efficiency than any form which gives better space for combustion, and less close proximity of the fire to the cooling surfaces It is not often that the two types of setting have been accurately and impartially compared, and hence data and results of trials, made by independent authorities upon boilers of nearly the same capacity, with practically the same coal, and under closely similar conditions, demand unbiassed presentation. It must be clearly understood that the following article is not a comparison between two different makes of boilers, but between two different types of furnaces, types which are open to the entire engineering profession for use, both on land and at sea, the whole forming a valuable contribution to practical steam engineering.—THE EDITORS.

PROBABLY most engineers who are interested in steam-boiler construction and economy, have the opinion that a highly heated brick furnace is more favorable to the complete combustion of the volatile hydrocarbons contained in bituminous coal than the cool surface of an internal furnace surrounded by water; but I think it is at least open to discussion whether the more direct utilization of the heat in an internal furnace, by which radiation and air leakage are avoided, does not more than offset the other advantages of the brick furnace. With either arrangement of furnace it is necessary to admit the proper proportion of air, and the air must be heated to a high temperature, say 1400 degrees F., in order to produce combustion of the volatile gases. This air is more easily and more naturally heated by passing through the bed of fuel on the grate than in any other way. If cold air is admitted above the fire, combustion will be checked, even with a brick arch; or if a large amount of coal is thrown upon the fire at once, the air supply will be checked and cooled so that the volatile gases, which are being rapidly set free, will, to a large extent, pass off unconsumed for want of sufficient heated air. Therefore, the question of obtaining perfect combustion with either kind of furnace is largely dependent upon the skill and care of the fireman in having the fire of such thickness that the air supply will be properly regulated and in carefully spreading the fuel in small quantities over the fire.

This result may be obtained mechanically either by the system of underfeed stoking or by down draft on the Hawley plan, by which

the volatile gases are forced to pass through the bed of incandescent fuel, thus receiving the heat and air necessary for complete combustion. Either of these systems of stoking may be carried out in a steel furnace surrounded by water as well as in a brick furnace. It is necessary, however, to have the internal furnace large enough to permit complete mingling of the burning gases before they come in actual contact with the cooling surfaces, and in this respect furnaces of small diameter, such as are used in the Scotch or Lancashire types of boilers, are at fault.

In order to make a comparison of the actual economy of the two methods of burning soft coal for steam generation, a table is given, comprising four trials of steam boilers—two of a water-tube boiler, set in brick, fitted with Dutch oven in front, and two of a boiler of the internal-furnace type. These trials were made at technical schools under the direction of careful and experienced men, and the results very fully and exactly recorded; they correspond closely in conditions, the boilers having about the same amount of heating and grate surface, the coal for three of the trials being from the same mine, and for the other trial of nearly the same calorific value.

The trials of the water-tube boiler with Dutch oven (A and C) are taken from a paper by Professor E. A. Hitchcock, of the Ohio State University, presented at the Saratoga meeting, June, 1903, of the American Society of Mechanical Engineers.

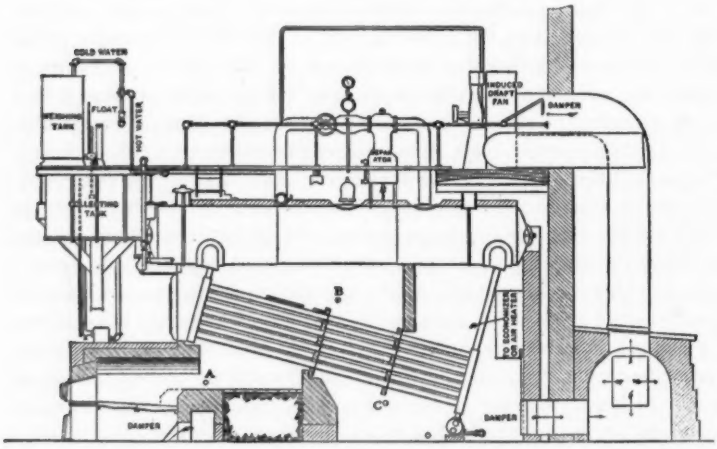


DIAGRAM OF EXTERNALLY FIRED BOILER WITH DUTCH OVEN USED IN PROFESSOR HITCHCOCK'S TESTS.

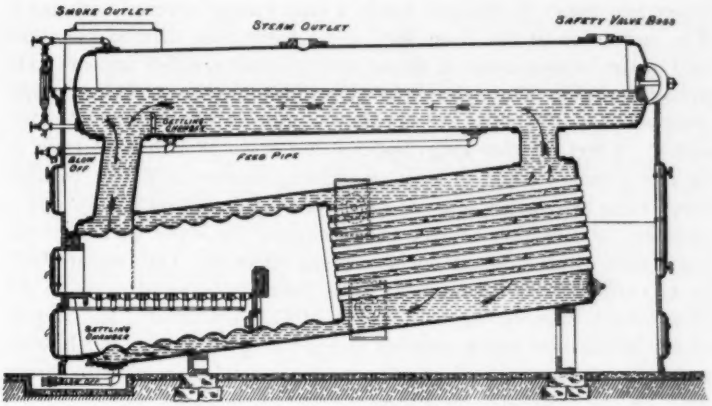


DIAGRAM OF INTERNALLY FIRED BOILER USED IN McGILL UNIVERSITY TESTS.

The trials of the internally fired boiler at McGill University (B and D) are taken from a report by Professor John T. Nicolson, D. Sc., formerly of McGill University, now director of mechanical engineering at the Municipal Technical School, Manchester, England, and Professor R. J. Durley, B. Sc., of McGill University.

Description of Boilers.—The equipment at the Ohio State University, especially constructed for the purpose of boiler and fuel testing, (referred to in trials A and C of the table annexed) consists of a water-tube boiler, a Green's fuel economizer, an air heater, induced and forced-draft fans. The boiler (of the Babcock & Wilcox type) has 56 4-inch by 16-foot tubes, and a 42-inch diameter drum, giving a heating surface of 1,070 square feet. The furnace is of the Dutch-oven or fire-brick-arch type with stationary grates, having an area of 25 square feet. The furnace projects in front, so that the front of the bridge wall is on a line with the front of the boiler, the arch extending 1 foot 6 inches beyond the end of the grate bars. The boiler is arranged so that it may be operated with or without the fuel economizer or the air heater, and with natural draft, induced draft, or forced draft.

The McGill University boiler, (referred to in trials B and D of the table annexed) is of the Robb-Mumford internally fired type, consisting of upper and lower water and steam drums connected by circulating necks. In the lower drum, the axis of which is inclined upwards about 1½ inches per foot of length, is a cylindrical firebox, from which the tubes lead to the rear head of the boiler. On leaving the tubes, the hot gases are passed over the external surfaces of the boiler between the

lower and upper drums and inside a steel casing covered with brick. The inclination of the lower shell and a baffle plate around the upper half of the furnace assist in the natural circulation which appears to be unusually brisk. The grate is fitted with rocking bars. The principal dimensions of the boiler are as follows: Lower drum 68 inches diameter by 15 feet 6 inches long; upper steam drum 38 inches diameter by 17 feet 9 inches long; furnace 49 inches diameter by 8 feet 3 inches long; tubes 2¾ inches internal diameter by 7 feet 1 inch long, 148 in number; total heating surface (not including the lower surface of the lower shell which although enclosed is not effective), 1,074 square feet; grate surface 24½ square feet. The boiler is in regular use in the MacDonald Engineering building of McGill University, and is part of the installation which supplies steam for light, power, and heating purposes. It can be worked either under natural draft or with forced draft on the closed-ash-pit system.

Apparatus Employed.—For both sets of trials at the Ohio and McGill Universities, draft gauges were used to measure the draft and thermometers and pyrometers to take the temperature of the air on entering the ash pits and the gases leaving the boilers, also for the feed water. Pressure gauges were used to get the steam pressure, and for the Ohio trials a Barrus calorimeter was used to determine the quality of steam. For the McGill trials the steam was taken as dry. For all trials weighing tanks were used for weighing the water, the weighing tanks opening into a collecting tank below from which the water was pumped to the boilers. All steam and hot-water piping was covered with non-conducting material; all fittings were made tight or blanked off to avoid leakage. The fuel was weighed, the time and weight of each barrow load being noted. Samples were taken with each barrow load for the determination of moisture and for calorimetric tests by a Mahler calorimeter, for the Ohio trials, and by a Donkin calorimeter for the McGill trials.

Methods Employed in Carrying on the Trials.—For the Ohio University trials (A and C) with brick furnace and setting, the boiler was fired continuously from thirty-six to forty-eight hours before the trial, in order that the brick work should be thoroughly heated. About two hours previous to the commencing of the test proper, the fire was drawn, the damper being closed, grate bars and ash pit cleaned, and a new fire immediately kindled with the coal to be used. This new fire was converted as quickly as possible to the condition to be maintained throughout the trial, the draft being regulated to give the desired fuel consumption and depth of fire fixed to secure the best consumption with the least amount of air excess. The tubes were

blown free of soot after starting the fire. About ten minutes before starting the test proper, the exact time being noted, the last fresh coal was thrown on, and five minutes later, the fire was levelled with a rake and the thickness determined by resting a bar on the bed of fire and levelling it by sighting on the level gauge and then noting the thickness by graduations on the fire door, which was open just enough to allow the rod to pass into the furnace. At the time for starting, the height of water in the boiler drum was noted on a scale reading in one-tenth inches, fastened to the gauge glass, and a string was also put on the glass at the same point, as a guide for the person controlling the feed water to the boilers. All readings were taken at regular intervals of one-half hour, commencing fifteen minutes after the test started. The firing was done at regular intervals of three to five minutes, depending upon the rate of combustion, and the amount fired was usually two shovelfuls. At the end of the trial, the same methods were employed as regards firing, the thickness of fire, etc., as at the beginning, and if the water in the boiler was not the same height by the scale, the necessary correction was made for this, based on the calibration of the boiler drum. The fire was then allowed to burn out, when all refuse was cleaned from the grates and the pit. The trials were conducted by A. J. Boehme, G. R. Bott, and J. S. Wilson, members of the senior class of mechanical engineering for graduation thesis, carried on under the direction of Professor Hitchcock.

For the McGill University trials, (B and D) at the commencement of a trial the fire was allowed to burn down until only just enough was left to light up a fresh fire, the stop valves being manipulated so as to keep the steam pressure constant. At the time of commencing, a known weight of wood (allowed for as half its weight of coal) was fired and firing then began with weighed coal. The fire was opened up as the production of steam increased. The end of the trial was taken to be the time when evaporation ceased, as the last of the weighed coal died down on the grate. Just enough fire was left to light up again. In this way, any uncertainty as to the depth of the fire at the beginning and end of the trial was avoided. The level in the water gauge was the same at the commencement and end in each trial. The trials formed a portion of the regular instruction course in the department of mechanical engineering at McGill College, and were carried out with the boiler at ordinary work, the remaining boilers in the room being steamed so as to take the fluctuations of the load so far as was possible. In no case was special preparation made for the trial, except that the tubes were swept just before the trial began.

TRIALS OF BOILERS.

(A and C with brick furnace—B and D internal furnace.)

Designation of trial.....	A	B	C	D
No. of trial (original report)	101 B.E.H.	2	160	3
Date of trial.....	Feb. 2, '01	Nov. 11, '98	Feb. 12, '02	Nov. 18, '98
Type of boiler.....	Water-tube	Int'l-furn.	Water-tube	Int'l-furn.
Duration of trial—hours....	10	8h. 5m.	9	8h. 22m.
Heating surface—sq. ft....	1,070	1,074	1,070	1,074
Grate " " "	25	24.5	20	24.5
Average Pressures and Temperatures.				
Steam pressure by gauge, lbs. per sq. in.....	134	102.5	98	111.5
Steam temperature, deg. Fahr.....	358	339.2	337	344.6
Draft at damper, ins. water.....	.16	.375	.552	.25
Draft in ash pit, " "	+ .08	.0	— .02	+ .46
Feed water, deg. Fahr.....	166	141	53.2	146
Escaping gases, " "	490	427	556	454
Air entering ash pit " "	158.5	39	57.9	70
Air used per lb. coal, lbs.....	19.41	17.5	18.6	18.9
Fuel and Water.				
Kind of coal,	George's Creek, R. M.	George's Creek, R. M.	Hackers Run (lump).	George's Creek, R. M.
Coal consumed per hr.—lbs.....	375	324.1	581.4	523
Moisture in coal—per cent.....	1.08	1.7	.85	2.2
Ash and refuse in coal, per cent.*...	8.9	6.6	10.48	6.8
Coal per sq. ft. grate per hour.....	14.8	13.23	29.07	21.35
Water evaporated per hour, lbs....	3,262	2,832	4,011	4,234
Factor of evaporation.....	1.094	1.115	1.203.	1.112
Evaporation per hour from and at 212°	3,569	3,157	4,826	4,708
Evaporation per lb. coal, lbs.....	8.69	8.75	6.889	8.09
Equivalent evaporation from and at 212° per lb. of coal—lbs.....	9.518	9.75	8.30	9.00
Heat Value of Coal and Efficiency of Boiler and Furnace.				
A—Heat used in evaporation, B.T.U....	9,192	9,580	8,016	8,480
B—Calorific value of coal, "	14,240	13,900	13,647	13,900
C—Efficiency boiler and furnace, A ÷ B = C = per cent.....	64.54	69	58.74	61

Ash and Refuse in Coal.

* The percentage of ash and refuse for trials B and D would have been higher if they had been taken from the analysis as they were for trials A and C instead of by weight. (See Prof. Hitchcock's paper, sec. 20), and for this reason the evaporation per pound of combustible is omitted.

Comparison of Trials.—Trials A of the external brick-furnace boiler and B of the internal-furnace boiler were made under natural or low-pressure draft, and trials C and D of the same boilers under forced draft. All of the trials show the evaporation per pound of

coal to be in favor of the internal-furnace boiler, and the total efficiency of the two types of boilers and furnaces based on the heat value of the coal, which forms the true test, shows 4.5 per cent in favor of the internal-furnace boiler for natural draft, and 2.25 per cent for forced draft. It will be noted, however, that the brick-set boiler and furnace was given the following advantages in the trials:—In trial A for the brick furnace with natural draft the air entering the ash pit was preheated to 158.5 degrees F., as compared with cold air at 39 degrees for the internal-furnace boiler, trial B. Professor Hitchcock's trials (Numbers 116 and 117) show that preheating the air to about the same extent gives a direct advantage of 2.4 per cent and an indirect advantage, as indicated by less CO in the escaping gases, of 1.3 per cent. So, it would appear that if the air had been preheated for trial B of the internal-furnace boiler it would have shown a total efficiency of 8.2 per cent better than the brick-set boiler and external furnace.

In the forced-draft trials (C and D) the grate surface was reduced to 20 square feet for the brick furnace and not for the internal furnace. Professor Hitchcock's paper (Sec. 26) shows that the reduced grate surface would give an advantage to the brick furnace through less excess of air.

Loss of Heat of Brick Work When Running Intermittently.—In the trials of the brick-set boilers with external furnace at the Ohio University it will be noted that the boiler was fired continuously from 36 to 48 hours before the trials, in order that the brick work should be thoroughly heated, and Prof. Hitchcock states in his paper (Sec. 20) that as a result of a series of trials made especially to determine that point, cold brick walls continued to absorb heat for 72 hours, and increased the loss during the trial 8.5 per cent., and he also states that brick-set boilers should be preheated not less than 30 hours before the commencement of a trial in order to give their best results. This shows clearly the advantage of an internally-fired boiler in cases where steam is used only during the day time or at intermittent periods, because the internal furnace will give as good efficiency during the first hour of steaming as at any subsequent period. The exact amount of loss in running a brick-set boiler during the day time only is not shown by these trials, but from Professor Hitchcock's results I think it fair to assume it would not be less than 4 to 6 per cent. in favor of the internal furnace.

It will be noticed in comparing the methods of starting and stopping that Professor Hitchcock used the running start, whereas in the McGill trials, the fire was burned down to the lowest possible point before starting and also at the end of the trial. While these methods

probably give about the same results, Professor Hitchcock's method would be in favor of the boiler, because the condition of his fire would be at its best from start to finish. It would also seem probable that a fire built up even two hours before the start, as was done in the Ohio University trials, might contain a greater amount of combustible matter at the beginning of the trial than at the end, when there would reasonably be a larger accumulation of clinker and incombustible material on the grate.

The McGill trials do not show any allowance for moisture in the steam; if we assume that the steam from the boiler contained the same amount of moisture as from the brick-set boiler, we should have to deduct 0.8 per cent for trial A and 1.7 per cent for trial C from the results of the internal-furnace boiler trials.

To sum up the comparison:— The comparative efficiency of the two types of boilers and furnaces as shown by the trials with the additions for preheated air in trial A, deducting the moisture in the steam, is 7.4 per cent in favor of the internally-fired boiler when the brick setting and furnace is preheated or run continuously; or if run in day time only, say 11 to 13 per cent. in favor of the internal furnace. Under forced draft and continuous running, the difference shown is slightly in favor of the internal-furnace boiler, although perhaps not outside the limit of error of testing; but under intermittent running the difference would be considerably in its favor.

It may be said that the differences shown by these trials in favor of the internally-fired boiler are within the limits of error of boiler trials conducted by different operators; but taking into account that the firing of the Ohio boiler was done by skilled men, and conducted with a view to getting the best results for the apparatus, while the McGill trials, although carefully conducted, were made with the regular fireman to show the students the methods of testing and the results under ordinary conditions of running; and considering further that the method of starting and stopping the trials at the Ohio University was rather more favorable to the boiler than at McGill—I think the comparison a safe one. But even if the internal-furnace boiler did not give any better results than the brick furnace and setting, it would show that the expense in first cost and repairs of a Dutch oven and brick setting are unnecessary; and especially considering the rapid deterioration and increase of air leakage incident to brick work, when subjected to the intense heat of combustion, they are objectionable as compared with the internally-fired self-contained boiler, which should hold its maximum efficiency in continued service and require much less repairs than the brick furnace and setting.

EDITORIAL COMMENT

WITH the definite settlement of the preliminary questions relating to the union engineering building in New York, so munificently endowed by Mr. Carnegie, attention may now be directed toward the execution of the work of design and construction in a manner which shall render the structure most efficient for its purpose.

While there is no doubt that the best architectural skill will be employed in the design of the building as a whole, it must be remembered that there are numerous features in connection with which the architects may wisely consider the peculiar conditions involved.

We have already illustrated and described in our issue of January last some of the most important houses which have been built in England, France, and Germany for similar purposes, and these examples contain numerous useful hints in this connection.

* * *

IN the first place the meeting hall should be designed with the fact always in view that it is to be mainly a place for the holding of general discussions from the floor rather than for the hearing of addresses from the platform. Nearly all large halls are built for the purpose of enabling an audience to hear what is said upon the platform. In the engineering societies the members who speak from their places in the hall should be heard as readily as the presiding officer, and a hall which is deficient in this respect will exert a most deterrent effect upon active discussion, something which would be most unfortunate. Probably the best examples of successful halls may be found in the rooms of legislative assemblies, such as the House of Representatives in Washington, or the Chamber of Deputies in Paris. The latter room is especially provided with a sort of lower rostrum, just beneath the elevated platform of the presiding officer and above the tables for the reporters, this being for the use of any member who is to address the Chamber. Probably something between the halls of Congress and a medical clinic hall would best serve the purposes of the meetings of the engineers.

Again, at all meetings of the societies there are those who wish to spend but a portion of the time in the main hall, preferring to mingle in conversation with their friends without. This should be made possible by providing a convenient and commodious conversation room, somewhat in the nature of a lobby, to which such ready access should be had as to enable members to leave the main hall and return without materially disturbing the meeting. Such a lobby is not to be confounded with the entrance lobby, where the arrival and departure of members would interfere with the purpose. Rather should it be behind the presiding platform, following again the arrangement in the Capitol at Washington, the access being provided by entirely different doors from those for the service of the arriving and departing members. Furthermore, the main hall should be provided with visitors' gal-

leries, thus enabling the floor to be reserved for members, permitting executive sessions to be held without unnecessary disturbance in clearing the room.

* * *

AN important use of the building will be for the holding of receptions, *conversazioni*, and similar entertainments, and it is especially a lesson of experience with existing structures that these involve special arrangements. Extensive cloak rooms for ladies and for gentlemen are necessary, and these should be readily accessible directly from the entrance, and yet so arranged as to avoid the formation of conflicting currents of arriving and departing guests, between the principal entrance and the main hall.

While the libraries will naturally be provided for in a quiet part of the building, there should be some convenient form of mechanical conveyor between the librarian's desk and the various meeting halls, together with telephone communication, so that books needed in the course of discussion may be produced with that promptness which alone can render them available.

These are but a few of the special requirements which may be readily provided if considered in advance of construction, but which would be found difficult and costly of attainment afterwards. A building for engineers should exhibit in every detail the latest evidences of engineering skill and judgment in construction and adaptation for its uses, and with all branches of the profession represented in its occupants there should be no difficulty in obtaining the best expert advice for every detail of the work.

* * *

WE have discussed repeatedly in our review columns the advantages of alcohol as a fuel for internal-combustion motors, and the paper of M. Henri Dupays in our issue for February last showed the extent to which the industrial applications of alcohol have grown in Europe. It is now proposed to permit alcohol which has been rendered unfit for drinking purposes to be relieved from the tax of $2.08 per gallon, and a bill to this end has been introduced into the house of Representatives by Mr. Boutell. The bill provides that alcohol, denaturized, to use the European term, by the addition of sulphuric ether, wood alcohol, methylic alcohol, naphtha, or other substances approved by the Commissioner of Internal Revenue and the Secretary of the Treasury, may be removed from distillery warehouses free of tax, the only requirement being the affixing of a ten-cent stamp, indicating its character. The act further provides penalties for the prevention of the redistilling of such denaturized alcohol, and for the storing of the material on the premises of any liquor dealer.

Such legislation is surely needed, and we hope that the bill will become law and that the United States may benefit by the encouragement of the manufacture of alcohol as a fuel for various purposes. It is a far safer and better fuel for automobiles than gasoline, and its production will enable recovery of much value from wastes of such industries as beet-sugar manufacture and the like.

Numerous forms of alcohol lamps have been devised in France and Germany, the flame from a properly constructed lamp rendering an incandescent mantle brilliantly luminous, and thus furnishing a safe and satisfactory substitute for gas and petroleum.

With slight modifications nearly every form of internal-combustion motor can use alcohol as fuel with high efficiency, and the only thing which is necessary to create an extended and desirable industry is the passage and sincere enforcement of the bill proposed by Mr. Boutell.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

MODERN FIREPROOF STRUCTURES.

RESISTANCE OF PROTECTED STEEL-FRAME BUILDINGS UNDER THE TEST OF THE GREAT FIRE AT BALTIMORE.

Iron Age.

THERE are a number of departments of engineering in which it is practically impossible for the completed product to be subjected to any test which shall determine beyond doubt the success which has been attained in the design and execution of the work. Thus a battleship may be prepared from the latest information available, and built from the best materials to be had, and may spend its entire life in cruising and in port, without ever having its real fighting value known. In like manner many so-called fireproof buildings are constructed and remain intact until superseded by some later structure, never having been exposed to any test by fire worthy of the name. For this reason every naval combat is eagerly studied by engineers and officers in order to learn how the different vessels really behave in action, and every great fire gives practical lessons in the art of fireproof construction.

In a recent issue of the *Iron Age* is given a fully illustrated review of the results of the great fire which occurred in the business district of the city of Baltimore, giving probably one of the most valuable reports upon the manner in which the modern steel-frame building, when properly protected, resists fire, which has yet been made.

The first reports, appearing immediately after the fire, contained much erroneous information about the manner in which the steel structures had resisted the fire, but when actual investigations became possible it was found that the tall buildings had not only stood the fire, but that they had, in some instances, served to protect to a partial extent the structures near them. When the Abbé Sieyès was asked what he had done during the French Revolution, he replied, "I survived!" and that answer alone spoke volumes. In like manner the protected steel-frame building survived the Baltimore fire, thus assuring engineers of the correctness of the ideas and methods which have been accepted as standard.

It must be remembered that such buildings, as at present constructed, are not intended to be proof against everything, and the principal idea has been to render them proof against injury from fire having its origin within.

"No effort has been made to guard against the attack from without to which the buildings were subjected. They were all filled with inflammable materials, had wooden window frames on the outside and wooden sash frames and doors within, and in the large majority of cases had wooden flooring laid over the concrete floors. Even though the windows on one or two sides of a building were protected by fire shutters, which was not generally the case, fire attacking the unprotected windows entered the building, raking it from floor to floor, and in many cases destroying the fire shutters, so that they hung in ribbons or fell from the building entirely. The spread of the fire was so rapid that ofttimes one of the tall buildings would stand directly in the midst of furious flames coming from all manner of 'tinder boxes' loaded with

highly inflammable materials, the flames licking up the four sides of their tall conductor and uniting over the top of the building, to be tossed on by the high wind against the next tall structure standing in their path. Under such conditions it is no wonder that the mullions between windows were warped and twisted when of steel, fused when of cast iron and cracked and crumbled when principally of stone or terra cotta. The condition of the upper floors of all the tall buildings shows that the heat was much more intense higher up than nearer the street level. This, of course, is quite natural, and, together with the eddies and currents of air created by the terrific suction, which must have been induced by the intense heat high above the pavement, is given by many as the explanation of the excellent condition in which some of the low fireproof bank buildings remained throughout the ordeal and also for much of the freakishness of the fire's course in leaving some things untouched and completely consuming others around the edge of its path.

"The experts who have made careful study of the catastrophe are united on one point, which stands out very prominently—that is, that the fireproofing of the steel members in the tall structures was good, but that what was needed to further protect the buildings was a system of outside fire protection or some means of keeping the flames outside. As to methods of attaining this end opinions differ, and while many believe that wired glass should be used in connection with protected metal window frames, others say that steel shutters would suffice if they covered all window openings. Still others hold to an outside sprinkler system, coming from various floors and forming a sheet of water around a building."

Although the general results of the Baltimore fire were such as to confirm the correctness of the principles upon which modern fireproofing are conducted, certain modifications in details were shown to be advisable. Thus there is danger in the use of very light steel framing, and thorough fireproofing involves a greater weight and stiffness than is demanded by the mere requirements for the loads to be carried. This is especially the case in connection with floor construction and wind bracing.

"It was the opinion that in many cases these were given too wide a span, and the beams were too light to safely hold the proper weight of arch. It has been suggested that these arches should not be of more than 5 feet 6 inches span, and should not be built of less than 9-inch tiling on 12-inch beams. They should also be provided with two tie rods each. The general practice in Baltimore has been to place about 1 inch of terra cotta covering around the lower flange of the floor beams. It has been suggested that this should be just doubled, as in very many cases the inch covering has cracked and fallen to the floor. Plaster composition partitions were proven of no value in resisting the fire, as wherever they were used they were completely destroyed. The consensus of opinion at Baltimore regarding the protection of steel columns was that at least 3 inches of terra cotta covering should be afforded, and that special covering should be provided for covering the piping, outside of the covering around the column.

"Another point shown is that the lightening of the terra cotta tile is a serious mistake, as with their thin webs, as now made, they do not withstand the heat as they should, and as a result the lower web cracks and falls to the floor below during the process of expansion and contraction during and after the fire. It was found that in terra cotta partitions and coverings to columns the tile of 8 inches in width or less held together better than those of more liberal outside dimensions. It was also found that the placing of a piece of wire cloth or similar substance in the joints, thus holding the cement from crumbling, would assist in holding the tile together."

So far as the exterior of the buildings is concerned, the fire showed that stone suffered the greatest damage, while ornamental terra cotta also broke away under the heat. The plainer designs of terra cotta, and the ordinary brickwork stood the heat best of all, and it was fairly well demonstrated that plain brick façades outside of protected steel skeletons, without other ornamentation, would have survived the fire uninjured.

The injury to buildings by the entrance

of fire from without has already been observed upon other occasions, notably in the case of the fire in the Home Life Insurance Company's building in New York, in 1898, fully discussed by Mr. Parsons in our issue of February, 1899; and the damage which may result from the entrance of fire through imperfectly protected windows is well known. This action was emphasised in the Baltimore fire. Commenting upon the subject in the *Iron Age*, Mr. Harry D. Gue, a specialist in insurance engineering, said:

"The most obvious lesson to be drawn from the conflagration in Baltimore concerns itself with the fatal weakness presented by window openings in the outside walls of buildings, unprotected against the attack of fire from without. Buildings having brick or stone walls, when erected in accordance with the laws of any city in America, are of sufficient strength to withstand the attack of ordinary neighboring fires, provided the outside window and door openings are made as fire resistant as the walls they pierce.

"Such protection is thoroughly practical and may be accomplished by either of two means; by iron shutters, or by wire glass windows in metal frames. Both types of protection are approved by fire underwriters, although wire glass windows are preferred by many on account of their obvious advantages. They do not require to be closed in a moment of emergency, being an integral part of the building; they are not subject to corrosion, they are eminently sightly, and when made of polished plate are suitable for use in building fronts where iron shutters are quite inadmissible. And above all, they offer a degree of fire resistance equal to the wall in which they are set."

The experience of Baltimore, then, is positive as to the possibility of constructing fireproof, or more correctly, fire retardent, buildings along the lines which have already been adopted. Plenty of good material in the steel skeleton structure, well protected with an ample thickness of terra cotta casing, and sheathed in brickwork, will stand any ordinary conflagration, and when the openings are guarded by heavy metal shutters or by wire glass, the building will resist even such a fire as took place in Baltimore, a fire far exceeding in intensity and extent anything within the ordinary bounds of probability.

BRITISH IRON-ORE SUPPLIES.

SOURCES OF IRON-ORE SUPPLY AVAILABLE FOR MAINTAINING THE OUTPUT OF BRITISH FURNACES.

West of Scotland Iron and Steel Institute.

THE question of iron-ore supply is a most important one in determining the future location of the industry. Great Britain owes much of her marvellous progress in manufactures and commerce to her supplies of iron and coal, while the rapid growth of the American iron and steel industries is largely due to the opening up of the immense resources of the northwest. In an interesting address delivered by Mr. Bennett H. Brough, Secretary of the Iron and Steel Institute, before the West of Scotland Iron and Steel Institute, the present position of Great Britain in respect of iron ore supplies is clearly discussed.

"From time to time pessimistic paragraphs are published in the papers telling us that the Bilbao mines are worked out, that other sources of iron ore supply have been secured by foreign competitors and that the home mines are no longer productive. In view of the fact that in 1902 Great Britain consumed two million tons more iron ore than in the previous year, it may be of interest to inquire to what extent such statements are accurate, and to review briefly the present sources of iron supply. The result will, it is believed, show that while it is true that the richest ores at Bilbao have been exhausted, and that more attention has been paid to calcination and to the washing of ores of inferior quality to enable them to meet market requirements, there need certainly be no immediate apprehension of a Bilbao-ore famine. Far-seeing British iron masters are, however, already making arrangements for the time when

substitutes for the Bilbao iron ores will have to be found. And happily there are still large fields of ore almost untouched, in Spain and in other countries.

"A study of the world's iron ore mines presents points of great historical interest, inasmuch as the history of iron mining goes back far beyond the periods of authentic records. In Europe the rich ores of Spain and Elba were much used during the Roman period. Remains of the Roman working of iron mines have also been found in the Forest of Dean, in the Weald of Sussex, in Belgium and in Austria. Indeed, the iron left in the slag heaps of the Forest of Dean furnished the chief supply to twenty furnaces for nearly 300 years. The ancient iron masters were unable to work any but the purest ores. The introduction of coal as fuel for smelting by Dud Dudley in 1618 and by Abraham Darby in 1713; the replacement of coal by coke; the invention of the modern steam engine by James Watt in 1770, of puddling by Henry Cort in 1784, of the hot blast by Neilson in 1828, of the Bessemer process in 1856, of open-hearth steel making in 1861, and of basic steel making in 1879, are a few of the great improvements that have stimulated the iron-ore mining industry and have rendered it possible to work impure material. Indeed, improvements in the methods of mining and of smelting iron ores have followed in rapid succession, with the result that the world in 1902 produced no less than 43,475,000 tons of pig iron—the result of the smelting of 87,000,000 tons of iron ore."

The development of the iron industry during the past half century has been remarkable, both for the increase in output and the changes which have occurred in distribution. Thus, in 1854, according to Mr. J. K. Blackwell, the world's production of pig iron was 6,000,000 tons, of which the United Kingdom produced 50 per cent., France and the United States each 12.5 per cent., Germany 6.6 per cent., and the balance by the other nations. In 1902 the total output has increased to 43,475,000 tons, but the United States now leads with 41 per cent., the United Kingdom following with 19.8 per cent., and Germany and Luxemburg together following with 19.3 per cent. Thus the United States produces about as much as the United Kingdom and Germany together, these three countries making more than 80 per cent. of the world's output.

Confining himself to the subject of iron ore, Mr. Brough showed that in 1901 the world's output was 87,000,000 tons, of which the United States produced 33.7 per cent., and Germany and the United Kingdom each 14 per cent. In 1902 the United Kingdom produced 13,426,000 tons of iron ore, valued at £3,288,000.

"Even that enormous output did not meet the consumption, and 6,898,000 tons were imported. Of that amount 82 per cent. was brought from Spain, 5.2 per cent. from Greece, 3.4 per cent. from Algeria, 2.8 per cent. from Italy (Elba), 1.6 per cent. from Sweden, 1.4 per cent. from Newfoundland, and smaller quantities from France, Turkey, Germany, Portugal, Russia and Australasia. In fact, the world is being ransacked for fresh iron-ore fields to supply rich ores for the British blast furnaces. The harbour at which most of the ore was delivered was Middlesbrough (1,177,000 tons); then followed Glasgow with 919,000 tons; and then Cardiff with 818,000 tons.

In Great Britain the principal iron-ore producing districts are Cleveland, in North Yorkshire, which in 1902 yielded 40.2 per cent. of the total output of the kingdom; Lincolnshire and Northamptonshire, yielding 26.7 per cent.; Cumberland, yielding 11.7 per cent.; Scotland, 6.2 per cent.; and Staffordshire, 6.1 per cent."

While there is no doubt that the rich ores of Bilbao and Elba are becoming scarcer, there are still large quantities of ore available in the north of Scandinavia, in the south of Spain, in Algeria, Canada, Cuba, South America, India, and China. The cost of carriage must always be an important factor, but this may be reduced by the great economies which are constantly being introduced. A great feature to be considered is the more general use of the basic open-hearth process, by means of which ores containing a higher percentage of phosphorus are rendered available for steel making.

The discussion upon Mr. Brough's paper emphasised the fact as to the gradual diminution in supply of Bilbao ore. In 1899 the output of these famous mines was 6,200,000

tons, while in 1903 this had fallen to 5,000,000 tons, and was steadily diminishing. When it is considered that the deposits have already yielded 115,000,000 tons, it is apparent that the time for diminution might well be expected. The great deposits of Swedish Lapland should next be considered, and the completion of the railway from the Gellivara district to the port of Narvik renders these deposits easy of access from England. Freight from Narvik to Grangemouth at 5s. 3d. compare favorably with the rates from Bilbao to the Clyde, and if transport and handling methods similar to those used on the Great Lakes in America are adopted there need be no fear for lack of supply.

The fact that the Lapland ores contain phosphorus need not be an objection, since the basic process, an English process in origin, although used far more in other countries, is well adapted for such ores. Nearly 80 per cent. of the steel made in Germany is basic-open-hearth product from phosphoric ores, so that question may well be left to take care of itself.

VANADIUM STEEL.

CONSTITUTION, PROPERTIES, AND PRACTICAL APPLICATIONS OF ALLOYS OF VANADIUM AND STEEL.

Léon Guillet—Académie des Sciences.

ALTHOUGH frequent notes have appeared in the technical press concerning the valuable qualities of vanadium steel there has been no published record of systematic researches into its properties. For this reason the paper of M. Léon Guillet, presented before the *Académie des Sciences,* and published in *Comptes Rendus,* is of importance and interest.

M. Guillet has made investigations upon two series of vanadium steels, the first containing about 0.20 per cent. of carbon, and the second 0.80 per cent. In each series the proportion of vanadium was increased from 0 to 10 per cent., especial attention being given to those containing 3 per cent. of vanadium, as being of the greatest industrial importance.

Considering first the results of micrographic examination, M. Guillet etched specimens of the 0.20 carbon steel with picric acid, and observed no material difference from carbon steel in appearance until the content of vanadium exceeded 0.7 per cent.; the pearlite was the same in appearance as in carbon steels, but the ferrite was rapidly colored a dark brown. As the content of vanadium was increased there appeared distinct white grains in the pearlite, these being plainly visible in relief upon polishing. These white grains developed with increasing proportions of vanadium until the pearlite was no longer visible, and when the alloy contained more than 3 per cent. of vanadium the white grains alone appeared, increasing in number and magnitude as the percentage of vanadium was increased.

Similar results were obtained with the steel containing 0.80 per cent. of carbon. Up to 0.5 per cent. of vanadium the structure was pearlitic, after which the white grains appeared and rapidly increased; and above 3 per cent. nothing else was to be seen. This product is a carbide, either a carbide of vanadium or a double carbide of vanadium and iron.

Three groups may be distinguished in considering vanadium steels:

1. Steels presenting the same structure as carbon steels;

2. Steels containing pearlite and vanadium carbide;

3. Steels in which all the carbon appears in the latter form.

The mechanical properties may be stated broadly as follows:

Steels of the first and second groups show a much higher ultimate strength and elastic limit than ordinary steels of the same carbon content; the elongation and reduction of area are medium, and they are much harder and more brittle than carbon steels. Thus, a steel containing 0.131 carbon, and 0.60 vanadium showed an ultimate resistance of 98,000 pounds and an elastic limit of 78,000 pounds. With a steel of 0.112 carbon and 1.04 per cent. vanadium the ultimate strength rose to 129,000 pounds with an elastic limit of 107,000 pounds per square

inch, the elongation being from 10 to 12 per cent.

Steels of the third group, containing 3 per cent. and more of vanadium show very low ultimate strength and elastic limits, the elongation becomes high, while at the same time they are very brittle. Thus a steel containing 0.187 per cent. carbon and 2.98 per cent. vanadium showed an ultimate strength of about 67,000 pounds and an elastic limit of about 27,000 pounds; while with 0.12 carbon, and 10.27 vanadium the ultimate strength fell to 43,000 pounds and the elastic limit rose to 30,000 pounds. A steel containing 0.737 carbon and 7.85 per cent. of vanadium had an ultimate strength of 43,000 pounds and an elastic limit of 19,000 pounds per square inch. For these alloys the elongation ranged from 16 to 24 per cent.

All of the vanadium-steel alloys are annealed to a slight degree by heating for a short time to a temperature of about 900° C. If the annealing is prolonged and a high temperature maintained, a precipitation of graphitic carbon occurs in a manner similar to that observed with other steels. Quenching produces a remarkable hardness in the steels of the first two groups, while it produces a slight softening of the third group. These effects appear to be produced regardless of the temperature at which the steel is quenched. M. Guillet extended his experiments in this respect up to a temperature of 1,200° C., and in no case did the quenching materially change the structure.

In general the following statements may be made concerning vanadium steels:

They may be divided into three distinct groups, one of these holding an intermediate position between the other two. Each of these groups may be characterized by its mechanical properties and those containing the special constituent present very remarkable properties. The experiments show that industrial applications may be expected only of those steels containing less than 7 per cent. of vanadium, and hence it is upon these alloys that further experiments should be directed.

The brittleness of the vanadium steels apparently prevents them from being used for the production of cutting tools, for which they would otherwise appear to be well adapted, but it is possible that this property may be modified by the addition of nickel. M. Guillet is at present engaged upon experimental researches upon nickel-vanadium steels, and promises to make his results public before long.

TRADE UNIONS AND EMPLOYERS' ASSOCIATIONS.

CONDITIONS UNDER WHICH SATISFACTORY OPERATIVE RELATIONS CAN BE MAINTAINED BETWEEN ORGANIZATIONS OF WORKMEN AND EMPLOYERS.

Charles W. Eliot—Boston Central Labor Union.

IT is not often that the president of a great university has the opportunity to address the members of a labor union, and unfortunately it does not appear that members of labor unions are generally desirous of listening to the words of eminent educators. It is therefore a matter for interested comment that the president of Harvard University delivered a thoughtful and pointed address before a powerful labor organization, and in his quiet and incisive manner told them some important truths concerning their relations to their fellow men. The address of President Eliot before the Boston Central Labor Union is to be examined as a unique example in the history of labor discussions with more than usual interest.

President Eliot does not mince matters. He admits from the start that there is a conflict, and also that the labor side has at first had the best of it. With the improvements in rapid communication the effective power of large combinations of men has been greatly increased, and the workingmen have been the first to utilize the telegraph, telephone, and quick mail service which together have made it possible for prompt, common action to be taken by men who are scattered all over the land. But the men have not been long allowed to retain their superiority in this respect, and within the past few years the employers have associated themselves in practically the same strength as the men, and have joined issue with them in various

ways. In some cases the employers have simply resisted the demands of the unions, but in many instances the result of the meeting of the two organizations has been the arrangement of a joint agreement, including the acceptance of wage rates, hours of labor, recognition, etc., on one hand, and the maintenance of peaceful relations on the other. This dual combination enables the combination to control prices and maintain a monopoly in prosperous times, but it does not hang well together in dull times.

In considering this present state of affairs, President Eliot says:

"Whither does this practice tend, and what are the natural limits of its power, if any there be? Under democratic law and custom and with the facilities which modern society possesses for quick intercourse and free exchange of views, these two monopolistic combinations, the union and the employers' association, have come into existence, and are capable of uniting in a common interest. What is the limit to the successful exercise of the tremendous power such a combination of two monopolies possess? The limit, I believe, is only to be found at the limit of the consuming power of the population. That consuming power is limited. It fluctuates from year to year, but it rises in civilized countries from generation to generation, and has risen prodigiously during the past 100 years. Nevertheless, its limits are much narrower than the modern monopolists appear to suppose."

There is necessarily a third party involved in the matter, the consumer, or as Dr. Eliot calls it, the whole community, upon whom the burden must fall, but it must not be forgotten that no man can belong wholly to one party only, since all men are consumers, and must form a part of the whole community, and any combination to perpetrate wholesale injustice must react upon every member of that community.

"There is, however, some clear gain to the whole community from the progressive rise in the prices of labor and of materials since labor unions began to put up wages. Invention has been strongly stimulated thereby—the invention of labor-saving machinery and of new materials or new combinations of materials. Every such invention adds to the power of man over Nature, and some of this added power ought to be credited to the unions. At this point some enthusiastic unionist may say, organize every trade and calling, so that there shall be no non-union public to suffer from the price-raising which 20th century unionism effects. But if we try to imagine the entire community divided into trade union groups, each group containing the union and the employers' association of its trade, we immediately perceive that the attitude of each single trade group toward its consumers will remain precisely what it is now. Society will be divided into monopolistic trade groups; but each group will be trying to get higher wages and profits by raising prices on its own goods. The union label will be on all goods, and therefore of no advantage to any, and the only market will be a higgling between intrenched monopolies. A demand consisting of many unionized monopolies will encounter a supply proceeding from a single unionized monopoly. This situation is almost unimaginable."

This phase of the situation reminds one of the Irish agitators, who proposed to kill all the landlords, so that they themselves might become the landlords, after which there would be nothing left but for them to kill each other.

That there must be some sort of a remedy to the armed truce of the two opposing camps, Dr. Eliot feels sure, and naturally he looks to that feature of life in which his own work has been done to discover the remedy. As a man whose entire life has been devoted to education, he sees in the fuller education of the combatants a means by which they may be brought to dwell together in peace.

Associations, both of workmen and of employers are all right, but there is no reason why they should not exist for beneficial purposes, as well as for those which are antagonistic.

"Industries which support thousands of workmen and hundreds of employers, both workmen and employers often need to take action through representatives, and must maintain organizations capable of choosing representatives. Apart from benevolent and social objects, those two forms of association would be maintained for the principal object of determining prices—the prices which each industry would bear.

A secondary object would be to improve steadily those sanitary and educational conditions of labor which make labor more efficient and both capital and labor more productive. Those two objects are perfectly harmonious, for since wages can in the long run only be paid out of product, the economic justification of higher wages is greater skill and efficiency in the individual workman, and their social justification is the increased total efficiency and happiness of the community. The process of determining what prices a given industry will bear is now a process of combat. The weapons have been chiefly strikes, boycotts and lockouts, all of which ordinarily involve bitter strife and violence, and not infrequently the disastrous interruption of a productive industry. This is certainly a very stupid way of arriving at a determination of the best price to be got in any year or at any moment for a given product. Conference and discussion between the workman, the capitalist and the trading agent, whatever he may be called, are the rational modes of arriving at a practical answer to the question of price; and this would be the mode adopted if right relations existed between capitalist and workman, each believing that the other had a genuine interest in the real success of the business they unite to conduct."

Whether this peaceable consummation can be reached or not depends greatly upon the kind of education which is acquired by the members of the opposing camps. Knowledge is undoubtedly power, but in many cases it is power which is employed for evil as well as for good, and it remains to be seen how far a modern training will help matters. Further education is certainly necessary, but it must be of the right kind.

"You and I and everybody must, in the first place believe, and must teach our children to believe, that brave men are not mere creatures of circumstances, slaves of blind forces, or tools of destiny, but are capable of molding circumstances, directing forces and changing destiny. And then each one of us might fight evil and promote good by his own personal endeavors and sacrifices. The forces of society, which seem so strong, often turn out to be weak when confronted by men who believe with all their hearts in pure ideals of freedom and righteousness."

THE FORM OF RIVER BEDS.

A THEORETICAL VERIFICATION OF EMPIRICAL LAWS GOVERNING THE FORMATION OF CHANNELS IN SHIFTING GROUND.

Annales des Ponts et Chaussées.

IT has long been known that in rivers flowing through soft ground the form of the navigable channel is affected by the curves and sinuosities of the stream. If a longitudinal profile of the river bed is compared with a plan of the stream it will at once be observed that there is a close relation between the concave curvatures and points of greatest depth. In general, the relation between the vertical and the horizontal curvatures of the channel is such that the spacing between the apex of the horizontal curves and the points of greatest depth is practically constant, being from one-fourth to one-fifth of the distance between two consecutive shallows. This fact, which has been worked into various empirical laws, appears to be a consequence of the general principles of hydrodynamics, and the relations which may be traced form the subject of a paper by M. Fargue, in a late issue of the *Annales des Ponts et Chaussées.*

M. Fargue considers first the normal resistances to the flow of a stream in a straight channel, examining the surface curve of velocities, and the position of the line of mean velocity in the cross section. Comparing these with the forces which act to oppose them, he works out the equations which result, and shows that the actual trajectory of the centre of flow may be computed for various values of the resistances. When the path of the stream is curved, instead of being in a right line, the centre of flow is also curved, but its trajectory is deflected in two directions, both horizontally and vertically, giving a sinuous curve of double curvature. The path is thus found to be resultant of two sinusoidal curves

having a definite relation to the axis of figure of the stream.

Applying the computations to a given example, it appears that the trajectory of the centre of flow is always deflected beyond the axis toward the concave face of the curve. This deflection causes a corresponding change in the position of the vertical curve, the maximum scour naturally appearing beneath the trajectory of maximum velocity. M. Fargue has compared his theoretical studies with comparative diagrams of the actual conditions on the Garonne and on the Scheldt, showing that the curve of the depths corresponds almost exactly with that of the direction of the stream, but displaced about one-fourth of the distance between maximum and minimum depths.

It thus appears that the general principles of hydrodynamics confirm fully the empirical laws which have been deduced from observation. It is, however, to be desired that a greater number of comparative observations be made, in order that the degree of approximation may be more precisely determined.

The practical bearings of these studies may readily be perceived. In the first place the old-time method of river regulation, attempting to confine a channel between rectilinear banks, is giving way to a more rational method of observing the reasons for curvature, and making use of them for controlling the direction of flow.

The manner in which depth may be caused by scour controlled by curvature has also led to a more scientific method of regulating the depth of channels, not only in the case of streams in which a definite current exists, but also in connection with tidal harbors where the entrance is obstructed by bars. Channels which are cut by dredging cannot be expected to remain if they are made in situations where the whole tendency of the natural forces is to fill them up, while if, by means of breakwaters, or similar artificial structures, a proper curvature is given to the flow the location of scour may be closely predetermined, and the channel produced and maintained by the very forces otherwise tending to close it.

Although experiments upon actual streams are to be desired in the study of the action of the current upon the bed, much may be learned in this connection by laboratory experiments. As already described in these columns, there is, in the laboratory of the polytechnic school at Karlsruhe, as well as at Dresden, an apparatus for reproducing upon a small scale practically all the conditions existing in large streams, with the added advantage of the ability to observe and record the results. By building up a miniature river channel, and constructing various deviating jetties and breakwaters, many practical problems may be reproduced and examined, so that the whole subject can be removed from the domain of hypothesis, and subjected to experimental demonstration. It is to be hoped that such experimental channels may prove as fruitful of practical results as the testing tanks have been in connection with the form and speed of vessels, and additional data obtained for working service.

THE STORAGE OF PIG IRON.

A COMPARISON OF THE CONDITIONS WHICH SURROUND THE IRON PRODUCER IN THE UNITED STATES AND GREAT BRITAIN.

George H. Hull—Iron Age.

IT has often been said that the iron market is the barometer of trade, and if it be taken to mean that the iron trade is an indicator, broadly speaking, of other trade conditions, the expression is not amiss. Doubtless the use of iron is a necessity for the conduct of all other lines of work, not only for those engineering industries and enterprises which require iron products directly, but also for all the great mass of secondary occupations which follow in their train. The iron trade, therefore, feels the demand very early, and also the slackness promptly, in periods of industrial fluctuations.

In a paper published in the *Iron Age*, and expanded in a subsequent reprint, Mr. George H. Hull examines the relation between demand and supply in the iron trade, with especial reference to the storage war-

rant system of England and Scotland, and the possibility of its introduction into the United States.

"In Great Britain, as in the United States, all constructive projects of any considerable magnitude, such as buildings, ships and railroads, are arranged for in advance by a contract between the projector and the builder. The projector first has prepared for him plans and specifications. Copies of these plans and specifications he sends to several builders for the purpose of securing several bids on the work. Each builder makes his estimate of what the work will cost, adds to this estimate a certain percentage for his profit, and then makes a bid on the work for a certain specified sum. If the projector accepts one of these bids he then enters into a contract with the successful bidder. This contract not only embodies a price for the entire work, but usually embodies a specified time in which it is to be completed. On work of great magnitude, which will require a long time to complete and which will consume a large amount of iron, it is customary for builders in each of these countries to protect themselves against any possible loss which might otherwise come to them by means of any large advance in the price of iron during the progress of the work.

"The manner of protecting themselves against such loss which has grown up in these two countries is radically different. To illustrate this difference, we will suppose that a contract has been made in each country, which provides for certain constructive work which is to be completed within 12 months; that this work will require 12,000 tons of iron at the rate of 1,000 tons per month.

"In the United States the builder protects himself against loss by making a contract with the iron producer to deliver him 12,000 tons of iron at the rate of 1,000 tons per month at the price current at the time the contract is made. Thus the risk of loss is transferred from the builder to the iron producer, without any compensation to the producer for the risk which he assumes. Through this custom it has come to pass that the American iron producer necessarily has his future product sold to the consumer at fixed prices for many months ahead.

"In Great Britain, on the other hand, the builder protects himself against loss by making a contract with the warrant dealer to deliver him warrants for 12,000 tons of iron, at the rate of 1,000 tons a month, at the price current on the day the contract is made. This protection is furnished at a rate of charges which are as well established in that country as are the charges for life, marine, or fire insurance. Thus, in Great Britain, by legitimate business methods, the risk of loss is transferred from the builder to the warrant dealer, who receives the customary rate of compensation for the risk."

Mr. Hull discusses at length the extent to which the business of issuing and handling such warrants has grown in Great Britain, and shows how it works in practice.

"There is an impression among many that in Great Britain consumers purchase by warrant the iron they consume. This is a mistake. Consumers buy nearly all the iron they use from the makers, or their agents. They each have their preference as to the brands they use, as well as the firms they buy from. Many of these business affinities last for a life time. The warrant which the consumers contract for as a protection are to them nothing more than a protection. As the months roll by they purchase the iron or steel they wish for their work of the brand, quality and shape they require, and simultaneously sell on exchange their warrants. If iron has gone up, say 20 shillings, they pay about that much more for their material, and they get that much more for their warrants. If iron has gone down, say 20 shillings, they buy their material for about that much less and get that much less for their warrants. In this manner they eliminate any speculative element from their business and thus insure their legitimate builders' profits."

In view of the success which has attended the warrant system in England and Scotland Mr. Hull believes that its general introduction into the United States would have an excellent effect in steadying prices and preventing in a great measure the fluctuations which now occur.

That there is no danger of an overproduction of pig iron by the creation of such a means of absorbing the production is indicated by the opinions of men well qualified to judge.

"The late Hon. Abram S. Hewitt, in a paper read before the American Institute of Mining Engineers in September, 1890, predicted that this country would require 14,800,000 gross tons of iron in 1900. This was not a figment of his imagination but the result of a mathematical calculation based on the actual increase of consumption during preceding years. For 40 years Mr. Hewitt's predictions relating to consumption have been more than verified; just as this one was.

"Mr. Edward Atkinson has recently predicted that the demand for iron in the United States will be at the rate of 40,000,000 tons per annum between 1900 and 1913. This prediction, like those made by Mr. Hewitt, is based upon a mathematical calculation of the progressive increase of the past. The demand will not increase gradually, but will increase suddenly, as it always has. Does not every thinking man know that if we were to accumulate a reserve stock of 10,000,000 tons in the United States before that date it would all be consumed during the first year of prosperity, and does he not know if such a stock is not accumulated we shall have a repetition of the same woeful experiences which the iron business has gone through eight times within the last 75 years?

"There is no danger of accumulating during a dull period more than will be consumed during the period of prosperity which follows. The largest reserve stock ever accumulated in the United States by the merchant furnaces was about 1,000,000 tons, equal to but a few weeks' consumption. If the United States had held, at the close of 1897, a reserve stock of four years' production it would all have been consumed in the six years which followed, together with a current annual production of 9,000,000 tons. Think of it; restricting production, with a reserve stock of 1,000,000 tons of iron, on the eve of a period of prosperity which required an extra supply of 36,000,000 tons."

In discussing the propositions of Mr. Hull, the opinion of one of the most experienced men in the American iron market, Mr. Archer Brown, may be quoted as of interest:

"A more ingenious system for producing extreme fluctuations in prices could not well be devised than the present one. While it continues we shall, of course, have alternating periods of great prosperity and great depression. Whether the iron trade of America could be educated to the point of carrying large stocks to be dealt in on the exchanges, is a matter about which difference of opinion has always existed. If one-half the energy and capital were put into it that have been back of the movements of cotton and coffee, or even the recent upward movement in the stock market, the public would become interested as a buyer, and would find scope for its speculative instinct in something that had real and imperishable value of securities backed by wind and water."

HIGH-TEMPERATURE MEASUREMENTS.

RECENT IMPROVEMENTS IN PYROMETERS AND IN THE PRACTICAL DETERMINATION OF HIGH TEMPERATURES IN INDUSTRIAL OPERATIONS.

Verein Deutscher Ingenieure.

NUMEROUS devices have been proposed and constructed for the measurement of differences of temperature, but the most familiar forms, such as the mercury and alcohol thermometers are adapted for narrow ranges of temperature only. Wedgwood, in the course of his practical work in the production of high-grade pottery, felt the importance of accurate temperature measurements, and his efforts to devise a method based upon the shrinkage of cubes of clay when exposed to heat are well known, although they are of interest now solely from a historical point of view. The later developments of pyrometry are discussed in a paper by Dr. Ludwig Harald Schütz, in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure*, from which we make some abstracts.

After describing the ordinary metallic thermometers, based on the expansion of a spiral of metals of different coefficients of expansion, Dr. Schütz refers to the improved mercurial thermometers, in which

the range is increased by the introduction of compressed nitrogen or carbonic acid in the upper portion of the tube, this enabling temperatures as high as 550° C. to be indicated, although the boiling point of mercury under atmospheric pressure is only 357° C. Another device which may be found useful for temperatures above the boiling point of mercury is the so-called thalpotasimeter, in which the temperature is indicated by the pressure produced by a confined volume of vapor. In some forms of this instrument the vapor of ether is employed, while in others the vapor of mercury is used. Such instruments are provided with a dial, enabling the pressure to be read directly, as well as with a recording lever, which draws a permanent record upon a moving band of paper.

For still higher temperatures the water pyrometer is sometimes employed, this being based upon the method of mixtures. A piece of metal, such as platinum, of known weight and specific heat, is exposed to the source of heat, and is then plunged into a known weight of water. From the rise in temperature of the water the temperature to which the mass of metal has been subject may then be computed by an appropriate formula. Numerous precautions must be taken with this method if accurate results are to be expected.

A form of pyrometer now very generally used for scientific observations, as well as for important practical operations is the thermo-electric apparatus of Le Chatelier. This device is based upon the fact that when two pieces of dissimilar metals are united and the point of union is heated, an electric current will be produced. To employ this principle for pyrometry it is necessary that the substances should be capable of resisting a high temperature, and also that a moderate current only should be produced. Le Chatelier employs two wires, one of pure platinum and the other of an alloy of platinum with 10 per cent. of rhodium, these being united at one end while the other ends are connected with a galvanometer. The two wires are enclosed in a porcelain tube, which serves to protect them and facilitates their introduction into a furnace, flue or other place.

The latest methods of temperature measurement, however, are based upon a different principle, giving rise to the so-called optical pyrometers. Probably the earliest form of optical pyrometer was that suggested by Newton, associating definite temperatures with certain colors. Following out this line Pouillet determined the temperatures accompanying the more conspicuous color changes, and these have been used for a long time as giving rough approximations. An improvement on the ordinary direct observation of a glowing body was made by Mesure and Nouel in what they termed a pyrometric telescope. This consisted of a tube containing two Nicol prisms, the first being fixed and the second capable of rotation through an angle measured by a graduated circular scale. Between the two prisms is placed a plate of quartz. The light is polarized by the first prism and partly rotated by the quartz. When the second, or analyzing prism is turned through the proper angle the polarized rays of light are obstructed, and the field becomes dark. If the light under examination is mixed the successive colors will become visible according to the angle through which the analyzing prism is rotated, and the angle through which this rotation must be made to obtain a certain color depends upon the composition of the light. This latter again depends upon the temperature, so that the angle of rotation may be made a means of indicating the temperature. Although this apparatus enables closer results to be attained than is practicable by direct visual observation, yet the difficulty of deciding that a previously observed color has again been produced renders any very high degree of precision impossible.

The later improved pyrometers, however, depend, not upon light rays but upon the actual emission of heat rays from the body whose temperature is to be measured. The researches of Lummer, Pringsheim, Wien and others have made it possible to determine the temperature of the dark rays emitted by a heated body, and upon this principle the latest forms of radiant pyrometers are based.

Thus the Wanner pyrometer, which has been tested at the Reichsanstalt for temperatures between 900° and 2,000° C., showing a maximum error of less than 1 per cent., is based upon the relation existing between the absolute temperature of a body and the

wave length of the emitted rays. According to the formula derived by Planck, there is a definite relation between the wave lengths of two sets of rays and the temperature of the bodies by which they are emitted, so that it is practicable to measure the relation between the temperature of an unknown body and that of one whose temperatures is known. This wave relation has been determined only for the dark rays, but it is quite possible to work with light-emitting bodies by using properly constructed apparatus.

Thus the light used for comparison may have its "black" temperature determined by previous comparison with a black substance. By then using for the comparison the waves of a single length for each substance the true temperature relation may be determined. The light used for comparison is generally an incandescent electric lamp, the rays from which fall upon a finely matted screen. The lamp used by Wanner shows by comparison a "black" temperature of 1,162° C. Waves of uniform length may be obtained either by use of colored glass or by decomposing the light by a prism and selecting a determinate portion of the spectrum, this latter being the method actually employed. The rays from both sources are passed through a direct-vision prism, and then through a Rochon prism, this latter causing polarization of the light in two directions, perpendicular to each other. The polarized light is then examined by means of a Nicol prism, and the angle of rotation required to make the two halves of the field equal in illuminating intensity is a measure of the temperature relation of the two sources. Thus the entire operation of temperature measurement consists in pointing the instrument at the source of heat and turning the eyepiece until equality of illumination is obtained over the whole field. The angle is then read off, and comparison with a previously prepared table gives the temperature.

Experiments made by Professor Wanner at the Ilse iron works showed the temperature of the flowing slag of a blast furnace to be 1,372° C., while that of the fluid iron ranged from this to 1,330°, cooling to 1,230° as it began to set in the mould. The temperature at the tuyeres, observed through the peep hole, reached 2,050° C.

SPACE DISTRIBUTION OF ENERGY.

PROGRESS IN THE DISTRIBUTION OF ELECTRIC ENERGY OVER THE SURFACE OF THE EARTH WITHOUT WIRES.

Nikola Tesla—Electrical World and Engineer.

THERE are a number of interesting and valuable articles in the recent anniversary issue of the *Electrical World and Engineer,* many of these over the names of men famous in all lines of electrical work. A large proportion of the papers, however, are historical and retrospective in their nature, and as such valuable mainly as matters of record. Among them, however, is a communication from Mr. Nikola Tesla, which is especially interesting as the first authoritative communication from him for several years in connection with his experimental work in connection with the electrical distribution of energy through space without the use of metallic conductors.

The success which has attended the employment of various methods of space telegraphy has prepared the public mind for a realization of the fact that wires are not necessary for the transmission of electric energy in such moderate amounts as may be necessary for purposes of communication over long distances, so that the extension of the subject to the distribution of energy in greater degree is not altogether incredible.

Mr. Tesla describes the laboratory which he established near Colorado Springs in 1899, this being equipped with instruments for investigating, among other things, the electric potential of the globe. This apparatus consisted of a highly sensitive self-restorative device, controlling a recording instrument, this being included in a secondary circuit, while the primary was connected to the ground and to an elevated terminal of adjustable capacity. The variations of potential gave rise to electric surgings in the primary, and these generated secondary currents, which in turn affected

the sensitive device and recorder in proportion to their intensity. With this apparatus the earth was found to be filled with electric vibrations, and these were thus subjected to continual observation and study.

One especial observation, made during and after a heavy thunder storm directed the attention of Mr. Tesla to a phenomena which he may best be allowed to describe in his own words:

"The recording apparatus being properly adjusted, its indications became fainter and fainter with the increasing distance of the storm, until they ceased altogether. I was watching in eager expectation. Surely enough, in a little while the indications again began, grew stronger and stronger, and, after passing through a maximum, gradually decreased and ceased once more. Many times, in regularly recurring intervals, the same actions were repeated until the storm, which as evident from simple computations, was moving with nearly constant speed, had retreated to a distance of about three hundred kilometers. Nor did these strange actions stop then, but continued to manifest themselves with undiminished force. Subsequently, similar observations were made by my assistant, Mr. Fritz Lowenstein, and shortly afterward several admirable opportunities presented themselves which brought out still more forcibly and unmistakably the true nature of the wonderful phenomenon. No doubt whatever remained. I was observing stationary waves.

"As the source of disturbances moved away the receiving circuit came successively upon their nodes and loops. Impossible as it seemed, this planet, despite its vast extent, behaved like a conductor of limited dimensions. The tremenduous significance of this fact in the transmission of energy by my system had already become quite clear to me. Not only was it practicable to send telegraphic messages to any distance without wires, as I recognized long ago, but also to impress upon the entire globe the faint modulations of the human voice, far more still, to transmit power, in unlimited amounts, to any terrestrial distance and almost without any loss.

"With these stupendous possibilities in sight, with the experimental evidence before me that their realization was henceforth merely a question of expert knowledge, patience and skill, I attacked vigorously the development of my magnifying transmitter, now, however, not so much with the original intention of producing one of great power, as with the object of learning how to construct the best one. This is, essentially, a circuit of very high self-induction and small resistance which in its arrangement, mode of excitation and action, may be said to be the diametrically opposite of a transmitting circuit typical of telegraphy by Hertzian or electromagnetic radiations. It is difficult to form an adequate idea of the marvelous power of this unique appliance, by the aid of which the globe will be transformed. The electromagnetic radiations being reduced to an insignificant quantity, the proper conditions of resonance maintained, the circuit acts like an immense pendulum, storing indefinitely the neergy of the primary exciting impulses and impressing upon the earth and its conducting atmosphere uniform harmonic oscillations of intensities which, as actual tests have shown, may be pushed so far as to surpass those attained in the natural displays of static electricity."

Mr. Tesla illustrates the central power plant and transmitting tower already constructed on Long Island, from which he expects to be able to send out waves for the transmission of messages in all directions, these to be received by a number of receiving instruments. The general idea, as advanced in Mr. Tesla's paper involves the employment of a number of plants, all of which are capable of transmitting individualized signals to the uttermost confines of the earth. Each of them will be preferably located near some important center of civilization and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it. Thus the entire earth will be converted into a huge brain, as it were, capable of response in every one of its parts. Since a single plant of but one hundred horse-power can operate hundreds of millions of instruments, the system will have a virtually infinite capacity, and it must needs immensely facili-

tate and cheapen the transmission of intelligence.

So far as the actual transmission of electrical energy for purposes other than the sending of messages is concerned, Mr. Tesla is also maturing plans for its exploitation. A plant is now being designed to be operated in connection with the Canadian Niagara Power Company, from which ten-thousand horse-power is to be distributed under a tension of one hundred million volts.

"This energy will be utilized all over the globe preferably in small amounts, ranging from a fraction of one to a few horse-power. One of its chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high-frequency currents and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus. These clocks will be exceedingly simple, will require absolutely no attention and will indicate rigorously correct time. There are innumerable devices of all kinds which are either now employed or can be supplied, and by operating them in this manner I may be able to offer a great convenience to the whole world with a plant of no more than ten thousand horse-power. The introduction of this system will give opportunities for invention and manufacture such as have never presented themselves before.

"Knowing the far-reaching importance of this first attempt and its effect upon future development, I shall proceed slowly and carefully. Experience has taught me not to assign a term to enterprises the consummation of which is not wholly dependent on my own abilities and exertions. But I am hopeful that these great realizations are not far off, and I know that when this first work is completed they will follow with mathematical certitude."

MAIN-LINE ELECTRIC TRACTION.

THE CASE OF THE INDEPENDENT STEAM LOCOMOTIVE AGAINST THE ELECTRIC MOTOR AND THE STATIONARY POWER HOUSE.

R. Bonnin—La Revue Technique.

WE have referred more than once in these columns to the possibilities of the successful application of electric traction to main line railways, showing that the change must be expected to develop gradually from the tramway and interurban railway, as the pressure for improved service becomes effective. The whole question is discussed from a conservative standpoint in recent issues of *La Revue Technique* by M. Bonnin, and the judicial nature of his treatment renders it especially applicable at a time when undue haste might prove prejudicial.

In treating of this important subject M. Bonnin at once disclaims any intention of treating of urban and local tramways, admitting that experience has shown these to be served far better by electric traction than is possible by steam locomotives. It is for the main lines of steam railways, operated under existing conditions, in which a limited number of express trains are intercalated between accommodation and freight trains of various speeds, that the problem of a change of motive power must be considered. Two questions enter into the solution of this problem—one, the question of cost, both of installation and of operation; the other, of the methods which may properly be applied to the use of electric traction for main-line railway service.

Since the second question has much to do with the reply to be given to the first, it may be considered before attempting to make a decision. Although the continuous current has shown itself especially applicable to local tramway systems of moderate length, it becomes too expensive to be employed for long lines without important modifications. The high-tension alternating current alone offers practical opportunity for the transmission of the necessary quantity of energy over the required distances, and this current must either be used in its original form, with or without reduction in pressure, or converted by proper machinery into a continuous current at properly located sub-stations. Both methods have been successfully employed, but the advantages of

using the alternating current either in polyphase motors, such as have been used on the Burgdorf-Thun railway, in Switzerland, or the Valtellina road in Northern Italy, or in single-phase motors of more recent design, is becoming apparent. Although M. Bonnin discusses especially the value of the polyphase system, it is evident, as noticed in these columns last month, that the single-phase motor is destined to be the most advantageous for the purpose. In any case the current must be conveyed along the entire length of the line, either through overhead wires, or by means of the third rail, the latter being now generally used for heavy currents. Taking into account even the best of the figures for these methods of transmission, M. Bonnin considers that the cost of installation must play an important part in the charge for equipment.

Admitting that the current can be properly transmitted and delivered, the advantages to be derived from the use of electric traction are to be weighed. One of the chief of these is the rapid acceleration attainable. There is no doubt that electric trains can be started very promptly and caused to attain full speed rapidly, this fact being mainly due to the superior adhesion obtained with the multiple-unit system, in which all the cars are propelled, thus distributing the effort among a great number of wheels. In the case of steam locomotives the acceleration is limited by the adhesion of the locomotive, and with heavy trains it is necessary to start slowly in order to avoid slipping the driving wheels. Special locomotives, constructed for the rapid handling of light trains for local traffic, have been found capable of a high degree of acceleration, and electric locomotives, hauling heavy trains, would be under the same disadvantges as steam engines under similar conditions.

An important advantage which has been urged for electric traction is the absence of reciprocating parts, and consequent freedom from vibration. While this advantage is not to be undervalued, it must be remembered that the modern four-cylinder compound locomotives can be so effectively counterbalanced that the vibration becomes almost inappreciable, so that this point becomes of minor importance in the comparison.

It has been argued for the use of electric traction that the advantage of transferring the generation of power from the moving machine to the stationary power house is a great advantage. Considered by itself this is doubtless true, but it cannot be so considered. The cost of transmission and application must be taken into account, and under such conditions as obtain in long-distance, intermittent transport, such as must exist on the greater part of the main railways, these become matters of controlling importance.

From the examination of a number of installations, M. Bonnin deduces that the actual cost of the power delivered at the driving wheels of the locomotives is about 15 per cent. higher for electric traction than for independent steam locomotives, and that in many cases it may rise as high as 45 per cent. greater. This is a matter which is so dependent upon operative conditions that it cannot be reduced to any definite relations. For a high traffic density there is every reason to believe that electric traction is more economical than steam locomotives, and the experience of the elevated railways in New York may be taken as sufficient demonstration of this truth. For longer distances, lighter traffic and fewer trains, however, the matter is reversed. With steam locomotives the cost is practically measured by the train-mile, but with a fixed plant equal to the whole maximum capacity of the road, as would necessarily be the case with electric traction, the proportion of fixed charges would be vastly greater and the train-mile as a measure of cost would disappeâr. To be profitable such a line must be worked continually at or near its maximum capacity, a most desirable thing, but not a matter which can readily be controlled.

Ultimately electric traction will play an important part in main-line transport, but its immediate applications must be found principally upon the more crowded lines in the vicinity of great cities.

M. Bonnin's conclusions naturally follow from his premises, but it is a question whether his premises are those which will actually regulate the matter. It is far more probable that the introduction of electricity as a means of transport will proceed along altogether different lines from the methods which have preceded it. Railways did not

follow the precedents existing in connection with the stage-coach service, except in some minor details, such as the arrangement of compartment carriages in European railways, and the like. Just so it may be expected that electricity will not make its way merely as a substitute for steam locomotive traction, but rather become the beginning force of some totally different system. What that system shall be remains to be seen. The possibility of admitting all sorts of mechanically-propelled vehicles to greatly improved highways is the possible development along what may be termed the individualistic system. The other extreme may be collectivist, so to speak, in the form of great trunk lines of continuously traveling platforms, like flowing rivers of merchandise and humanity, never stopping, but collecting and discharging its burdens *en route*. Which of these shall prevail, or what other system may appear cannot now be predicted, but it is almost certain that the older methods will be altogether transformed, and that electric power will capture them rather than be itself appropriated.

ELECTRICITY IN MINES.

REPORT OF THE HOME OFFICE COMMITTEE UPON THE SAFE USE OF ELECTRICITY IN MINING OPERATIONS.

Colliery Guardian.

FOR more than a year an important committee has been engaged in investigating the conditions under which electric transmission of energy may safely be used in mining operations, and the report of this body to the Home Secretary has recently been made public.

The work of the committee has included hearings of opinions from scientific experts and makers of electrical apparatus, colliery proprietors, miners, and insurance representatives, together with experimental demonstrations of the working of apparatus, ignition of explosive mixtures, and practical workings of machinery in existing colliery installations, and the work appears to have been very well done. The length of the report prevents its publication here, but an abstract of the main conclusions is given.

In the first place, the committee was impressed with the fact that electricity possesses such advantages that its general use in mines must become general, and hence the only question lies in the prevention or minimising of the dangers which may accompany its use. In this respect it is pointed out that the dangers involved in the employment of electricity are no greater than those due to other appliances, such as steam machinery, mining explosives, and the like. At the same time the use of electricity adds one more to the dangers of mining work, and every possible precaution should be taken in its use. In this connection, however, it must be remembered that the presence of a supply of available power will relieve miners from much severe and dangerous manual labour, so that the use of the electric current removes some sources of danger, even if it may add others.

The first point which is emphasised in the report is the importance of having first-class material and workmanship. In many existing installations the plant has grown from small beginnings, the additions having been made without proper regard to the safety of the whole. Such a state of affairs necessarily accompanies the pioneer stage of the work, but it should no longer be tolerated. But a small portion of the prime cost is saved by bad work, while the loss from a single accident might destroy the whole. For this reason the committee thinks that electricity, like high explosives, should always be considered as a source of potential danger, and hence that it should be originally of good quality, and subjected to periodical tests, while being at all times under the care of competent persons.

So far as pressure is concerned, the idea that there is safety in low voltages is not sustained; 650 volts is permitted at the face, while higher pressures are permitted in other parts of the mine. No especial location for cables is given, owing to the different working conditions in different mines, but good insulation is required, and every possible protection against external injury, together with convenient access for examination and repair.

The report is decidedly favorable to the use of three-phase motors for mining use, largely because of the absence of commutators and freedom from sparking. Doubtless the improvements in single-phase motors which are rendering them suitable for tramway use will also make these available for mining work, a most desirable solution of the question. Stationary motors should be inclosed, and so placed that they may be efficiently ventilated with intake air. By placing the machines in a closed room, free from the dangers involved in contact with air which has passed through the mine, the use of flame-tight casings is rendered unnecessary. Uninflammable materials should be used as far as possible in the construction of motor rooms, and the measuring instruments placed in the room, where they can readily be seen by the attendant.

Numerous attempts have been made to design motors which may be safely operated in an explosive atmosphere, but such a performance must necessarily be risky, and while every care should be taken to provide against the possibility of the ignition of gases, such working should be discouraged. The presence of gas can readily be ascertained by the use of a safety lamp, and the machines should be immediately stopped until the gas has been removed.

Electric locomotives, although most convenient for mining service are to be considered only for mines free from firedamp, the inevitable sparking at the trolley contact rendering them inadmissible where there is danger to be apprehended from the ignition of gas.

Electric lighting has already been well regulated by the rules prepared by the Council of the Institution of Electrical Engineers, and to these there need only be added the precautions involved in the possible ignition of gas. Experiments have demonstrated that if the bulb of an incandescent lamp is broken in an explosive mixture of air and gas the gas will generally be fired. Lamps should therefore be protected with strong glass globes, when the danger becomes less than with the ordinary safety lamps.

The advantages of the use of electricity for shot-firing and for signalling are so generally accepted that it was only necessary for the committee to formulate rules for their regulation, although the former of the two matters also comes within the scope of the regulations for explosives in coal mines.

It has undoubtedly been most difficult for the committee to deal closely with the details of installations so necessarily varied as must exist in mines. Much must be left to be determined by the local conditions, but there is every reason to believe that if the instructions are carried out in the spirit in which they have been framed, and every effort made to use the best appliances in properly skilled hands, the use of electricity in mining operations will add no new dangers of importance, and may remove existing ones of greater moment.

PRODUCTION AND APPLICATIONS OF OZONE.

RECENT PROGRESS IN THE CONSTRUCTION OF GENERATORS AND IN THE USE OF OZONE IN THE ARTS.

Marius Otto—Société des Ingénieurs Civils de France.

THE bleaching and sterilising effects of ozone have long been known, and numerous laboratory experiments have been devised for illustrating these properties. More recently ozone has been used for the purification of drinking water, and we have reviewed in these columns the work of Abraham, Marmier, Erlwein, Andreoli, and others. There appears to be no doubt as to the sterilising effect of ozone upon pathogenic bacteria contained in water if proper devices are employed for effecting intimate contact of the particles and the principal question at issue in relation to the practical operation of the process lies altogether in the cost. For this reason the paper of M. Marius Otto, recently presented before the Société des Ingénieurs Civils de France is of present importance, treating, as it does, not only of the commercial applications of ozone, but also of methods of generating it at moderate expense.

M. Otto touches briefly upon the subject of statical ozonators, cooled either by water

or by air, and then passes to the more practical question of the design and operation of rotary generators for producing ozone in considerable quantities at commercial prices.

Briefly, ozone is produced by the condensation of atmospheric oxygen by the action of silent discharges of high-tension electricity. When two electrodes are placed upon glass plates so that high tension discharges pass from one to the other, the air between them becomes ozonized. If a flow of air is maintained the air charged with ozone may be drawn off continuously and diverted to the desired application. The practical difficulties are found, first in the heating of the electrodes, and second, in the tendency to form arcs and short-circuit discharges. Under such conditions it becomes difficult to operate the apparatus continuously and at a high rate, restrictions which materially affect the cost of the product.

The rotary generators, as described by M. Otto, are based upon the principle of movable electrodes, the discharges passing directly between the metallic surfaces without the interposition of any dielectrics. By keeping the parts constantly in motion a high density and large output may be maintained without the formation of arcs or sparking discharges. It is evident that this principle may be used in a variety of ways; one of the forms described by M. Otto consisting of a number of sheet-iron discs mounted upon a vertical rotating shaft within a cast-iron cylinder, the discharges passing from the discs to the interior of the cylinder, and the flow of air to be ozonized being through the interior of the cylinder. With such an apparatus, which may be made of large size and capacity, the cost can be lowered by the production of ozonized air in bulk, and its industrial applications widely extended.

The experiments of M. Otto have shown that for sterilising and bleaching purposes a high degree of concentration is not necessary, and that from 1.5 to 2.5 grammes of ozone per cubic metre of air is a satisfactory proportion. The quantity of ozone absorbed by a cubic metre of water in producing a complete sterilisation is very small. Even when a large proportion of germs are present the actual amount of organic material to be oxidized is exceedingly low. According to the experience of M. Otto a proportion of 0.5 to 0.8 gramme per cubic metre of water is sufficient, and this is borne out by the experiments of Dr. Erlwein.

The cost of production naturally depends upon local conditions, and accurate figures can be obtained only after greater experience with large installations has been had. M. Otto states that the actual cost of the electrical energy is less than 0.01 franc per cubic metre, while the results of the installation at Wiesbaden show a cost of 0.4 pfennig per cubic metre. The establishment and operative charges other than that for power depend upon the manner in which the business is managed. Taking the installation at Wiesbaden, under the management of Dr. Erlwein, for the sterilization of drinking water, the total cost per cubic metre is given at 2 pfennigs, of which 0.4 pfennig is for electrical energy, 1 pfennig for operative expenses, and 0.6 pfennig for depreciation and interest. This corresponds to a little less than 2 cents per thousand U. S. gallons, a figure which may safely be used for similar installations elsewhere.

The method of sterilising water in quantity consists in using a preliminary rapid sand filtration to remove suspended inorganic impurities and a portion of the bacteria, and then causing the water to descend through a tower filled with broken porous material, such as coke, against an ascending current of air charged with ozone. The air which has been used should be returned to the ozone generator, as it is still partly charged, and a distinct economy is effected by using it again. M. Otto describes a variety of small ozonizers, or, as he calls them, "electric filters," these being arranged to bring the water into contact with ozone as it is drawn from the tap. Such devices are well adapted for household use as well as for hospitals, and in most cases they are intended to be operated in connection with small statical ozone generators, although the larger rotary machines may be used when occasion warrants it.

An interesting application of ozone is found in Paris in connection with laundry operations. The soiled linen is first placed in large vessels, which are closed and steam admitted to moisten the articles. A current of ozonized air is then passed through

the vessel, thus effectively sterilising and whitening the articles. After the washing, the clothes are dried in an atmosphere charged with ozone, which effects a final bleaching, without the slightest injury to the material. The importance of such a system in connection with hospital work, or in time of epidemics can readily be seen, and in any case such a method of cleansing and whitening is greatly to be preferred to the use of strong alkalies and bleaching agents containing chlorine.

TECHNICAL TRAINING IN THE WORKSHOP.

HOW THE SCIENTIFIC GRADUATE IS BEING UTILISED IN THE DEVELOPMENT OF MANUFACTURING AND INDUSTRIAL ESTABLISHMENTS.

R. Mullineux Walmsley—Institution of Electrical Engineers.

AMONG the various reports which have been made of late in England upon the nature and value of technical training in other countries, may be noted the extensive paper of Dr. R. Mullineux Walmsley to the Institution of Electrical Engineers, discussing Transatlantic engineering schools and engineering. Although the entire paper contains much valuable and interesting matter concerning technical training in America, it is impracticable, in view of the large amount of attention which has been given to the subject in these columns, to review this portion here. There is, however, in the report some very valuable matter relating to a side of the subject which has not been as fully discussed as its importance demands, viz., the use to be made of the technically trained man when you have got him.

After having described very thoroughly the training which is given in the best scientific schools of the United States and Canada, Dr. Walmsley proceeds to examine the "product" of such a training, with a view to the determination of the best applications which can be made. Dr. Walmsley truly says that the chief value of a technical training, such as is given in these institutions, lies, not so much in the actual detailed information which the student acquires as in the grip of fundamental principles, and an alertness of mind which enables the possessor, almost unconsciously, to apply those principles to any problems as and when they arise.

"In addition, he should acquire the attitude of a mind which is never content with the beaten track, although that track may be a good one, but is always on the lookout for fresh and more advantageous developments, and is willing to face the risk of failure which new developments, however scientifically directed, may involve.

"Such an attitude of mind, together with the fundamental knowledge which alone renders it of value, the writer believes is acquired by a fair number of the graduates of the most up-to-date institutions in the United States and Canada; and the employment of such trained talent in the industries in which science and its applications play an important part cannot but have a marked effect upon real progress.

"It remains therefore to inquire whether this talent and intellect when trained is, as a matter of fact, drafted into the service of the engineering industry, and in examining this question the writer carried his inquiries to the two principal classes of people who were likely to know the facts, namely, to the principals and the deans of the engineering faculties of the universities and colleges visited, and to the employers of engineering labour on an extensive scale to whom the majority of the graduates must look for at least the commencement of their careers subsequent to leaving college. Without exception the officials interviewed asserted that, far from having any difficulty in placing the graduates turned out year by year from the engineering courses, for the last few years the graduate class has had every one of its individual members engaged for remunerative work before the completion of the course at the college. Inquiries amongst managers and employers confirmed this claim advanced on behalf of the colleges, though in some instances a doubt was expressed as to whether in the case of the less known and more academic of the institutions the claim could be fully substantiated, but in these cases, however, it was conceded that the best graduates had

no difficulty in obtaining positions, and it was only the tail-end of the class which might have to wait for some months or even abandon the attempt to get immediately remunerative employment."

In many of the larger establishments, such as the Westinghouse Company, and the General Electric Company, none but engineering graduates are taken at all as pupils, and in no case is any premium required, but, on the contrary, a living wage is paid from the start.

The wisdom of this plan appears in the fact that within a year or two at most these young men have earned promotion and are earning substantial salaries because of the value which they have shown in their services to their employers.

This is in marked contradiction to the practice in Great Britain. How can the benefits of technical training be realized by the nation when the products of such training, the men themselves are not welcomed into the shops and given opportunity to apply their trained ability to productive work? The influence of the American system cannot be traced directly, but it can by inference, as Dr. Walmsley well shows, from its connection with the engineering industry of the country.

"That this influence must be great is shown by several methods of deduction:—

"First:—That the employers liberally support the schools by taking their graduates, by giving facilities to the undergraduates for work in their vacations, and last, but not least, by liberally contributing towards equipment.

"Secondly:—That the graduates are taken on at a living wage, *no premium being required,* and that a fair chance is given to capable men to rise irrespective of family or other influence.

"Thirdly:—To any one who has walked through any of the large electrical engineering works, the presence of the experimenter and his testing staff in every part of the works shows that the brains drawn from the colleges are being utilised.

"Fourthly:—The rapid development of the engineering industries in the United States during the last ten years warrants at least the cautious deduction that this development is due to some extent to the utilisation of the brains trained in the schools, though, of course, the older men who have directed the movement had not, in many cases, the advantage of a college education.

"Fifthly:—Incidentally the quickness with which any new idea, wherever originating throughout the scientific or engineering world, is taken up and worked for all that it is worth in America, may be held to be fair evidence of the influence of the college-trained graduate, well posted in the literature of his special branch of engineering, and keenly alive to all discoveries."

Applying the result of his investigations in America to the situation in Great Britain, Dr. Walmsley shows that improved methods of training and preparation are needed at home, but he also emphasizes the fact that the most is not being made of existing opportunities and men. There is much good material available, more than is at present being used. British deficiencies are classified as follows:

"First:—In the lack, by many of our leading manufacturers of support and encouragement of the work of the colleges, either by offering positions to the best college graduates to start their works training at a living wage, or by actively assisting the colleges in the same ways as their American competitors. The attitude of the British employer toward the college-trained men is greatly influenced by the premium system which so largely prevails in this country, for in many cases the first question asked from a young man who seeks to enter the works of an engineering firm is, not what his previous training has been, but what premium his friends are prepared to pay. Cases in which pupils offering a premium are refused, because of their lack of training, are probably few and far between. Worse still, in many cases the only advantage the pupil purchases with his premium is having the run of the shop or works without any real discipline, on the off chance that he will "pick up" the necessary knowledge and experience. What struck the writer most in his investigations in America was the entire absence of this system, and the prevalence in its place of the system of offering to the college-trained men commencing positions at a living wage, and the almost universal comment of the

employers that it *paid* to do this. It is not too much to say that the existence of the premium system in this country acts as an incubus upon the supply of brains for the engineering industries. The vested interests involved, however, are so great, that it is only an overwhelming sense of the importance of the subject that induces the writer, with much trepidation, to give expression to his convictions, the result of careful examination and study.

"Secondly:—Even were the employers prepared to take students on the same relative scale as their American competitors, our present schools are neither equipped nor staffed to produce in sufficiently large numbers the trained men who would be demanded. But, as it is, the best products of our existing schools do not get that encouragement at home which should be forthcoming, and a fair proportion find in the States the opportunities which are denied to them at home. The writer found not a few instances of men trained at the Central Technical College, and elsewhere, holding their own well against the graduates of American colleges.

"Thirdly—and in great part as a consequence of the first point noted, parents and guardians in this country have not yet been educated to understand how essential, in view of the great developments during recent years, college training is to the success in the future of a candidate for the engineering profession. Influenced by the well-known arguments about the advantages of so-called "practical" training, they pay the premium demanded in the fond hope that they have provided the youth with a secure path to professional success in life. The frequent disillusion at the end of the apprenticeship term is pitiable, and the writer has met with many cases in which it might be fairly described as heart-breaking."

To sum up, it will be noticed that under each head it is the employers and manufacturers who hold the key to the position, and it is for them to say whether the leeway is to be made up within this generation or postponed until it is too late. Vested interests are the greatest difficulty, but is it too much to hope that they will not continue to block the way?

SUBMARINE CABLES IN WAR TIME.

CABLE COMMUNICATION WITH THE FAR EAST AND THE METHODS OF MAINTAINING COMMUNICATION DURING THE WAR.

The Electrician.

APPLIED science enters into all departments of life and work, and rules which have been formulated for older conditions have to be modified continually in accordance with the changes which are continually taking place.

An interesting example of the manner in which modern appliances enter into politics is seen in the question of cable communication with those parts of the world which are affected by the war between Russia and Japan. From a discussion in a recent issue of the *Electrician* we abstract some notes upon this matter.

At the time of the laying of the Pacific cable it was noted in these columns that there was a certain degree of protection in the construction of lines which included terminals upon the territory of various nations, because of the fact that all such powers would be interested in maintaining open communication. A similar opinion now appears to exist in other quarters. The *Electrician* calls attention editorially to the fact that a Russian or Japanese ship attempting to cut an English cable landing on neutral territory only would be acting in defiance of international law, and theoretically be committing an act of piracy.

In the East at the present time cables connecting Japanese and Russian territory have been interrupted, although they were owned by British companies. Japan, however, is connected to the mainland by way of Formosa and China, and by way of Corea, both of these being Japanese government cables. There is every reason to believe that these cables will be subject to attack by Russia and of defense by Japan, and it remains to be seen how vulnerable a cable really is under such conditions. Japan possesses a cable ship which is capa-

ble of repairing any damage which may be done, while Russia has no such vessel at the scene of conflict, but as her efforts will be directed mainly to destruction and not to repair work, this point is of minor importance.

If the plan of the United States government to make telegraph connection between Japan and the island of Guam, on the route of the American Pacific cable is carried out, Japan will not be isolated even if all the other cables are cut.

In this connection the extent to which a cable by the northern great circle route would have entered into the situation may be noted. Although the line, as shown by Mr. Emerson in the issue of this Magazine for November, 1899, included a touch at Cape Lopatka, in Russian territory, this might have been passed by upon emergency and Japan reached direct from the island of Attu, with a line which Russia would scarcely have ventured to interrupt. That such a line may yet be constructed is within the bounds of possibility, and if Japan should be successful in her present struggle it may be begun from that end of the route.

The possible interruption of communication in war time, however, cannot but stimulate the introduction of systems of space telegraphy which, communicating through the ether, shall be without tangible material for destruction by the enemy. Already it is reported that the entire Japanese fleet is equipped with wireless apparatus, and the proximity of the Japanese islands to the American possessions in Alaska and the Aleutian islands makes it possible that a chain of Marconi stations may replace any metallic connection. The right to maintain communication is one which all nations will maintain to the best extent of their ability, and if the less civilized powers attempt to interfere with that right, the scientists and engineers of the world will see to it that such attempts are rendered unavailable.

THE STEAM TURBINE PROBLEM.

METHODS OF UTILIZING DIRECTLY THE ENERGY OF A STEAM JET DISCHARGING INTO A VACUUM.

H. F. Schmidt—American Electrician.

THERE is evidently little doubt in the mind of most steam engineers that the steam turbine is destined to replace the reciprocating engine for very many purposes, and the question to be discussed is rather the best form of steam turbine to be adopted. All credit must be given to Mr. C. A. Parsons for the ability and energy which he has brought to bear upon the solution of the question, and his work must always remain as that of a pioneer in this important field. The problem has broadened out, however, and has become a question for general discussion and application, and the paper of Mr. H. F. Schmidt, in a recent issue of the *American Electrician*, is an excellent contribution to the subject.

Mr. Schmidt begins by a mathematical examination of the action of a steam jet, deriving fundamental formulas for turbines, these being primarily in the form suitable for simple machines, and then expanded to render them applicable to multiple-stage turbines.

Assuming an initial pressure of 150 pounds per square inch absolute, and a pressure of one pound absolute in the condenser, a velocity of 3,950 feet per second results for the jet of steam.

"This enormous velocity is almost 75 per cent. greater than that of a shot from one of our large modern rifles. In order to obtain maximum efficiency, the velocity of the buckets must be half this value, which is so great that even the most tenacious material known could not withstand the resulting centrifugal strain, even though the wheels were made of large diameter. How to obtain with this enormous jet velocity the maximum efficiency without having prohibitory bucket velocity is the problem.

"This has been accomplished in two general ways, in both of which a series of revolving bucket wheels and stationary guide blades are grouped alternately. These

methods are broadly represented by the Parsons turbine, which is of the reaction type, and the Rateau and Curtis turbines, which operate on the impulse principle. Each of these turbines accomplishes the desired result by reducing, in stages, the velocity of the issuing jet of steam. The bucket wheels do not travel at one-half the velocity of the jet, but considerably less, so that the fluid leaving the buckets has a backward velocity relative to the revolving wheel. If it be reversed in direction by a set of guide blades, it may be caused to impinge on a second set of buckets, and so on, until the velocity is practically reduced to zero. In the Parsons turbine, the steam enters the first set of buckets without having been considerably expanded and at a comparatively low velocity; expansion takes place continuously through the buckets and guide blades, and as the velocity is being constantly reduced by expansion, it is at the same time being constantly reduced by its passage through the buckets till at last it leaves the turbine almost devoid of motion. Hence, it is evident that as the velocity of the fluid through the turbine is almost constant, and the volume of the fluid is constantly increasing, the area through the buckets and guide blades must be correspondingly increased; and as with this system the entire circumference of the wheels must be used, in order to avoid making the blades of too great radial depth, the diameter of the wheels must be increased from the admission to the exhaust end of the turbine. In this type, the buckets are filled with expansive fluid, which on account of the difference in pressure between adjacent rows of buckets will tend to leak around the moving and stationary blades; it is necessary to have the clearance spaces between the stationary and revolving parts as small as possible in order to avoid excessive leakage."

The principal difference between the Rateau and the Curtis turbines is that the latter has reduced the large number of stages originally employed by M. Rateau to four or more, M. Rateau having used as many as twenty-five. M. Rateau applied the multiple-expansion system to the simple turbine of De Laval, and Curtis has followed in the same line.

"The losses in the turbine, as in all machines, may be divided into two classes—the inevitable and those which may be reduced by improvement in design and construction. It is therefore well to separate them in considering turbine construction. Taking up the various sources of loss in the turbine in the order that they appear in passing from the supply main to the exhaust, the first part to be considered is the nozzle. Here there cannot be any considerable thermal loss as the area from which radiation can take place is extremely small in comparison to the heat energy of the medium passing through it in a unit of time. Nevertheless, losses occur here due to the friction of the fluid on the sides of the orifice, and, owing to the reduced sectional area of the nozzle in comparison with that of the main supply pipe, eddies are formed which materially reduce the velocity of the jet. The greatest loss here is caused by incomplete expansion of the medium in the nozzle as it is impossible to reduce the final pressure below a certain value for practical reasons. Next in order, as the working fluid passes through the turbine, it passes through the buckets. Since the buckets or vanes are constantly passing the nozzles, the jet must enter and leave the vanes from either the top or the sides; hence there will be an unavoidable loss here, which is considerable. In passing through the buckets, losses occur due to friction and on account of the formation of eddies. The first cannot be reduced to any great extent, but the second can be reduced very materially, the best shape for the buckets being determined experimentally. For the reaction type of turbine the cross-section of the buckets should be parabolic, and for the impulse type, circular. In both cases, the edges of the buckets should be tangent to the direction of the jet.

An interesting application of the turbine, to which Mr. Schmidt does not refer, is that of Rateau in employing the low-pressure turbine to be operated with the low pressure steam discharged by a high-pressure reciprocating engine. In this way a large portion of the energy remaining in the exhaust of pumps, hoisting engines and similar machines may be converted into useful form, and the possibilities of the turbine for this work should not be overlooked.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Fourth Street Bridge, Waterloo, Iowa. Abridged address of M. L. Newton before the Iowa Engng. Soc. An illustrated article describing the construction of a Melan arch bridge of 7 spans, having a total length of 586 feet over all. 3500 w. Eng Rec—Feb. 13, 1904. No. 60779.

Saving a Sinking Concrete Arch Bridge. Illustrates and describes the method adopted for saving a bridge at Mamaroneck, N. Y. 800 w. Eng Rec—Feb. 6, 1904. No. 60668.

The Arch Bridges on the Albula Railway (Die Gewölbten Brücken der Albulabahn). With details and photographs of the important masonry arches on the line of the new Engadine railway, in Switzerland. Three articles, 3000 w. Schweiz Bauzeitung—Jan. 16, 23, 30, 1904. No. 60927 each B.

The New Stone Arch Bridge of 295 feet Span at Plauen, Saxony. Illustrations with general description. 900 w. Eng News—Jan. 28, 1904. No. 60564.

Drawbridge.

Twin Lift-Bridge Operated by Gas Engines; New Draw Over Newark Bay,

We supply copies of these articles. See page 157.

Central R. R. Co. of New Jersey. Illustrates and describes a drawbridge of unusual design erected under difficult conditions. 1600 w. Eng News—Feb. 25, 1904. No. 61081.

Girders.

The Continuous Girder Upon Elastic Supports (Der Durchgehender Träger auf Elastisch Senkbare Stützen). L. Vianello. A graphical examination of a difficult problem in statics, with applications to practical examples. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 30, 1904. No. 60919 each D.

Two Large Plate Girder Railway Bridges. Describes and illustrates two plate girder railway bridges of span exceeding 100 feet. 2500 w. Eng News—Feb. 18, 1904. No. 61043.

Highway Bridge.

Stone Highway Bridge Over the Connecticut River at Hartford. Drawings and information concerning a new bridge 1,185 feet long and 80 feet wide between parapets, with a 100-foot Scherzer rolling lift double-draw span over the canal which is on the west bank of the river, and eight semi-elliptical granite-faced arches. 1500 w. R R Gaz—Feb. 19, 1904. No. 61033.

Metal Bridges.

Rules for the Design of Metal Bridges on the Prussian State Railways. From *Zentralblatt der Bauverwaltung*. Methods of construction, calculation of strength and weights, bending moments and shearing stresses, &c. 4000 w. Bul Int Ry Cong—Jan., 1904. No. 60644 E.

Removal.

Moving a Paris Footbridge Over the Seine and Withdrawing Its Piers by Hydraulic Jacks. Rene Bonnin. An illustrated account of the methods used in moving the Passy Footbridge. 2000 w. Eng News—Feb. 18, 1904. No. 61041.

St. Petersburg.

The Troïtsky Bridge Over the Neva at St. Petersburg (Le Pont Troïtsky sur la Neva à Saint-Pétersbourg). P. Bodin. Detailed illustrated description. The construction is mixed cantilever and hinged arch, with a swing span at one end. 2500 w. 1 plate. Génie Civil—Jan. 23, 1904. No. 60902 D.

Viaduct.

The Des Moines River Viaduct of the Chicago Great Western Railway. The present number gives an illustrated description of the substructure, towers and truss spans. 2400 w. Eng Rec—Jan. 30, 1904. Serial. 1st part. No. 60551.

The Herkimer Viaduct for the Utica and Mohawk Valley Railway. Wilbur J. Watson. An illustrated description of this structure and its construction. 3000 w. Eng Rec—Feb. 27, 1904. No. 61088.

WATERWAYS AND HARBORS.

Breakwaters.

The Breakwater at Buffalo, New York. Discussion of the paper by Emile Low. 3000 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60745 E.

Congress.

The Ninth International Navigation Congress (IX. Congrès International de Navigation). Additional reports of the French delegates. 50000 w. 14 plates. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60938 E + F.

Dredging.

A Desirable Method of Dredging Channels Through River Bars. Continued discussion of a paper by S. Maximoff on this subject. 5500 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60744 E.

The Dredging Fleet of Montreal Harbor. H. A. Bayfield. A discussion of such points in the operation of a dredging fleet as are of interest to dredging men. 4900 w. Can Soc of Civ Engrs—Jan. 14, 1904. No. 60725 D.

Floods.

Floods and Flood Protection Works at East St. Louis, Ill. James F. Parr. Abstract of a paper read before the Illinois Soc. of Engrs. & Survs. Relates to the experience of East St. Louis during the flood in June, 1903. 3300 w. Eng News—Feb. 4, 1904. No. 60680.

The Kansas River Flood. Charles Alma Byers. Remarks on the changes made in the river channel. 2000 w. Sci Am Sup—Feb. 13, 1904. No. 60800.

Inland Navigation.

From Sea Coast to Lakes. C. A. McAllister. An interesting account of an all-water trip from New York to Milwaukee, Wis. Illustrated. 4500 w. Marine Engng—Feb., 1904. No. 60649 C.

Mississippi.

Making the Southwest Pass of the Mississippi a Ship Channel. An account of a great engineering undertaking now under way, for which Congress has appropriated $1,750,000. 2500 w. Sci Am Sup—Feb. 20, 1904. No. 61055.

Panama Canal.

The Republic of Panama. Wm. H. Burr. An illustrated article describing the country, customs, climate and conditions, and discussing the various projects for a ship canal. 6400 w. Nat Geog Mag—Feb., 1904. No. 60726 C.

Rhine.

A Hydrologic Study of the German Rhine (Etude Hydrologique du Rhin Allemand). Ed. Maillet. An examination of the work of the special commission having in charge the flood-warning system of the Rhine within the German Empire. 5000

We supply copies of these articles. See page 157.

w. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60940 E + F.

River Beds.

The Form of Beds of Navigable Rivers (La Forme du Lit des Rivières Navigables). M. Fargue. A study of the manner in which the empirical laws are found to be verified in actual instances. 5000 w. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60939 E + F.

River Regulation

The Cache River Drainage Survey. A. H. Bell. Abstract of a paper presented to the Illinois Soc. of Engrs. and Survs. An account of the work and the condition of the river. 1200 w. Eng News—Feb. 4, 1904. No. 60678.

The Vicksburg Harbor and the Yazoo River Diversion Canal. Walter H. Polk. An illustrated description of interesting engineering work which has given new life to the city of Vicksburg. 3000 w. Eng Rec—Feb. 20, 1904. No. 61025.

Tide Gates.

Automatic Tide Gates for the Bolsa Chica Gun Club, California. Jas. D. Schuyler. Illustrates details of construction. 600 w. Eng News—Feb. 4, 1904. No. 60677.

CONSTRUCTION.

Air-Lock.

Special Pneumatic Lock for the Harlem River Tunnel. Illustrated description. 600 w. Eng Rec—Feb. 27, 1904. No. 61093.

Bins.

Grain Pressures in Deep Bins. J. A. Jamieson. Outlines tests, calculations and discussions on this subject previously published, and presents information gained by conducting a systematic series of tests, calculations and investigations and deductions drawn. Also shows cause of certain failures, and describes a number of designs of grain bin construction. 11500 w. Can Soc of Civ Engrs—Adv Proof—Feb., 1904. No. 60724 D.

Concrete.

See Civil Engineering, Materials.

Fire Proofing.

An Account of the Baltimore Fire, with Some General Deductions. H. D. Bush. 1700 w. Eng Rec—Feb. 20, 1904. No. 61022.

Detail Studies of Fireproof Buildings in the Baltimore Conflagration. An illustrated article giving reports of various engineers who have examined the ruins. 8000 w. Eng News—Feb. 25, 1904. No. 61080.

Iroquois Theatre Fire. F. J. T. Stewart. A full report of this unfortunate disaster, with 6 plates and line illustrations. 4000 w. Ins Engng—Jan., 1904. No. 60741 C.

Steel structures in the Baltimore Fire. Gives 32 illustrations and an account of the effect of the fire upon different types of buildings, remarking on the lessons in fire-proofing taught by this disaster. 7000 w. Ir Age—Feb. 25, 1904. No. 61057.

The Baltimore Fire. An illustrated account of the fire, describing the condition of the burned buildings and giving much information of interest. Map. 7500 w. Eng Rec—Feb. 20, 1904. No. 61021.

The Recent Great Fire in Baltimore. Some facts in regard to the electrical service. 800 w. Elec Wld & Engr—Feb. 20, 1904. No. 61029.

The Record of the Fire-Proof Building in the Baltimore Conflagration. The story of this fire and the destruction wrought based upon careful study by experts. Ill. 3500 w. Eng News—Feb. 18, 1904. No. 61037.

Freezing.

Freezing as an Aid to Excavation in Unstable Material. James H. Brace. Synopsis of the result of a research of the literature on the above subject. 21000 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60743 E.

Reinforced Concrete.

See Civil Engineering, Materials.

Roads.

The Use of Tar on Roads (Goudronnage des Chaussées). An account of the use of coal tar for laying dust on the highways in the Department of Seine-et-Marne, France. 10,000 w. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60941 E + F.

Roofs.

Details of the Large Timber Roof of a Public Shelter in Van Cortlandt Park, New York. Illustrates the timber roof framing and main truss of a roof covering an area of about 85 by 162 feet. 900 w. Eng Rec—Feb. 27, 1904. No. 61092.

Steel Roof Trusses in the New Union Railroad Station at Washington. Describes details of an elaborate roof, giving diagrams. 1800 w. Eng Rec—Feb. 6, 1904. No. 60664.

Tunnels.

Tunnelling Machine; Great Northern, Piccadilly and Brompton Railway. Brief illustrated description of the invention of Mr. Price. 500 w. Engng—Feb. 5, 1904 No. 60828 A.

Underpinning.

Jacking Down Open Cribs for Underpinning. Describes interesting construction work carried out in New York while erecting a steel-eage office building at the corner of Fulton and William streets. 1400 w. Eng Rec—Jan. 30, 1904. No. 60555.

We supply copies of these articles. See page 157.

MATERIALS OF CONSTRUCTION.

Cement Works.

New Cement Works at Portland, Colo. James D. Schuyler. An illustrated description of an interesting plant. 2200 w. Eng Rec—Feb. 20, 1904. Serial. 1st part. No. 61024.

The Edison Portland Cement Works. Illustrated detailed description of this remarkable plant. 1700 w. Sci Am Sup—Jan. 30, 1904. Serial. 1st part. No. 60573.

Concrete.

Concrete Hollow Wall Construction. Illustrates and describes this system of construction, claiming that it hastens drying and drainage, saves material and labor, and other advantages. 1500 w. Min & Sci Pr—Jan. 30, 1904. No. 60669.

More Light on the Theory of Concrete. Spencer B. Newberry. Read before the Indiana Engng. Soc. Discusses materials, proportions, &c. 1800 w. Eng Rec—Feb. 6, 1904. No. 60665.

Lead.

Lead Architecture. J. Starkie Gardner. An illustrated article reviewing the uses made of lead from the earliest history of the metal. Especially describes lead architecture in the past, and some suggestions for its use in the present. General discussion. 10000 w. Jour Ry Inst of British Archts—Jan. 23, 1904. No. 60871 B.

Reinforced Concrete.

A Plea for a Committee on Steel-Concrete. Ross Francis Tucker. Showing the need of rules and regulations for the guidance of engineers using this material. 1200 w. Eng Rec—Feb. 6, 1904. No. 60666.

The Kelly & Jones Company's Concrete-Steel Factory Building. An illustrated description of the Ransome system of construction; some of the details are of special interest. 1600 w. Eng Rec—Feb. 6, 1904. Serial. 1st part. No. 60663.

The Siegwart Ferro-Concrete Floor Beams. Illustrates and describes this type of floor construction. The beams are made in the factory. Reports tests made. 1200 w. Engng—Jan. 29, 1904. No. 60712 A.

See Civil Engineering, Bridges.

MEASUREMENT.

Approximations.

Inaccuracy in Some Engineering Approximations; Formulas for Elevation of Outer Rail on Curves. W. D. Taylor. Calls attention to cases of approximation where inaccuracies occur. 900 w. Eng News—Feb. 18, 1904. No. 61040.

MUNICIPAL.

Havana.

The Sanitation and Proposed Sewerage System of Havana, Cuba. A. E. Carter. Describes the conditions found when the U. S. army entered in 1898, and what has since been accomplished. The water supply and sewerage systems. 2500 w. Sch of Mines Qr—Nov., 1903. No. 60835 D.

Incinerator.

Rubbish Incineration in New York City and the Design for the New Stanton Street Incinerator. Illustrated description of the new plant, with information of interest. 4000 w. Eng Rec—Jan. 30, 1904. No. 60553.

Pavements.

Concrete Foundation and Cement Filler for Brick Pavement. O. L. Gearheart. Read before the Illinois Soc. of Civ. Engrs and Survs. Discusses the economic relations between concrete foundations of different compositions and cement filler. 1800 w. Eng Rec—Feb. 13, 1904. No. 60781.

Maintenance of Asphalt Pavements in Washington, D. C. Capt. H. C. Newcomer. An explanation of methods used for this work, the prices, etc. 1200 w. Eng News—Feb. 18, 1904. No. 61042.

The Bitulithic Pavement. W. A. Hoyt. From a paper before the Michigan Engng. Soc. Observations and conclusions gathered in superintending the construction of this pavement. 3800 w. Munic Engng—Feb., 1904. No. 60750 C.

Sewage Disposal.

Filters versus Contact Beds in Sewage Purification. W. S. Shields. From a paper before the Indiana Engng. Soc. Considers the septic tank as used in England and America, and the opinions concerning it, and describes filtration plants of interest, especially sand filters, operated intermittently and automatically. Ill. 3000 w. Munic Engng—Feb., 1904. No. 60749 C.

Sewerage and Sewage Disposal at Bedford, Ind. G. C. Houston. From a paper before the Indiana Engng. Soc. Describes the system adopted for a hilly surface, and the treatment given the sewage. 2000 w. Munic Engng—Feb., 1904. No. 60748 C.

Sewers.

The Wear of Sewer Inverts. E. A. Hermann. Explains the cause of the wear and the effect on various types and materials, the information being based largely on the sewers of St. Louis. Ill. 1500 w. Eng. News—Feb. 4, 1904. No. 60681.

WATER SUPPLY.

Austria.

Description and History of the Water Works and the American System of Filtration at Trieste, Austria. E. A. Gieseler. Map and illustrations. 2000 w. Eng Rec—Feb. 20, 1904. No. 61019.

City Supplies.

Some City Water-Supplies. E. H. S.

Bailey and Edward Bartow. Considers the supply of the Neosho River System for the cities of Chanute, Oswego and Chelopa, giving analysis and conclusions. 2500 w. Bul Univ of Kansas—Vol. II., No. 7, Nov., 1903. No. 60753 D.

Filtration.

A Rapid Filter Plant for the New Chester Water Company. Illustrates and describes a plant having a capacity of 4,000,000 gallons per day. 2200 w. Eng Rec—Feb. 27, 1904. No. 61090.

Hot Water.

Supplying Hot Water to an Office Building. A brief description of how the water is heated and supplied. 1000 w. Met Work—Feb. 13, 1904. No. 60757.

Irrigation.

Windmill Irrigation in Kansas. Philip Eastman. An illustrated article describing the transformation wrought by windmill irrigation. 1800 w. Rev of Revs—Feb., 1904. No. 60529 C.

Ozone.

See Electrical Engineering, Electro-Chemistry.

Santa Barbara.

The Proposed Tunnel for Water Development for Santa Barbara, Cal. A statement of the conditions at this place, and the means proposed for assuring an adequate water supply. 800 w. Eng News—Feb. 18, 1904. No. 61038.

South Dakota.

Notes on the Water Supplies in the Black Hills of South Dakota and Vicinity. Ellen H. Richards. Remarks on the importance of securing uncontaminated supplies for mining camps, with information concerning peculiarities of the region named. 1000 w. Tech Qr—Dec., 1903. No. 60747 E.

Typhoid.

Special Reports on Typhoid Fever and Water Supply. Statements from city officials in Philadelphia, Lowell, Mass., and Waterloo, Iowa, and in Western Pennsylvania. 3700 w. Eng News—Feb. 11, 1904. No. 60790.

The Typhoid Fever Epidemic at Columbus, O. Prof. F. H. Eno. A statement of the conditions leading up to and at present pertaining to the epidemic of typhoid fever now prevailing, with editorial comment. Map. 7200 w. Eng News—Feb. 11, 1904. No. 60791.

Typhoid Fever History and the Water Supply of Pittsburg, Allegheny and Vicinity. Prepared from data and comments thereon obtained from various health officials, giving information of the water supply systems. 6000 w. Eng News—Feb. 25, 1904. No. 61083.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The Manufacture of Multiple-Core Telephone Cables with Air Insulation (Die Fabrikation Mehradiger Telephon-kabel mit Luftisolation). J. Schmiett. Describing methods of manufacture employed by several German firms. 2500 w. Zeitschr f Elektrotechnik—Jan. 17, 1904. No. 60968 D.

Cable Steamer.

See Marine and Naval Engineering.

Exchange.

The New Trunk Exchange of the Post-Office Telephone Service. Begins a detailed description of an exchange which provides telephonic communication between London and provincial and Continental towns. 900 w. Elec Rev, Lond—Feb. 5, 1904. Serial. 1st part. No. 60815 A.

Microphone.

Improvements to Maintain a Uniform Action of the Micropohone in Telephony (Neuerung zum Erreichen einer Dauernd Zuverlässigen Wirkungsweise des Mikrophons im Fernsprechbetrieb). H. Stosberg. Showing the proper proportioning of the resistances to insure permanency of action. 800 w. Elektrotech Zeitschr—Feb. 4, 1904. No. 60963 B.

Space Telegraphy.

On the Wave Length of Free Vibrations in Antennæ and Closed Oscillating Circuits. Dr. James E. Ives. Describes experimental investigations on the wave length of antennæ and of closed circuits. Deals with the change in wave length produced by inserting turns of a wire helix. 1000 w. Elec Wld & Engr—Feb. 6, 1904. No. 60688.

The Work of a Wireless Telegraph Man. Winthrop Packard. An illustrated article explaining how messages are sent and received at sea, and how wind and weather affect transmission. 2000 w. World's Work—Feb., 1904. No. 60581 C.

Wireless Telegraphy. R. G. Blaine. The introduction gives a review of the history of wireless telegraphy, to be followed by a study of the various systems. 3200 w. Elec Engr, Lond—Jan. 29, 1904. Serial. 1st part. No. 60706 A.

We supply copies of these articles. See page 157.

Telegraphy.

Efficiency of the Railway Telegraph Department. J. C. Browne. Discusses maintenance and operation, interruptions and their causes, and means of improving the service. General discussion. 5500 w. St. Louis Railway Club—Jan. 8, 1904. No. 60736.

Telephony.

The Tone Test. A. Dallam O'Brien. Describes the principle and operation of the tone test as used in connection with calls completed over long-distance and toll lines. 2200 w. Am Electn—Feb., 1904. No. 60595.

DISTRIBUTION.

Factories.

Electrical Transmission of Power as an Aid to Greater Economy in Works and Factories. George Harland Bowden. Read before the Bradford Textile Assn. Discusses engineering detail in connection with the application of electric power to mills and factories. 3800 w. Elec Engr, Lond—Jan. 29, 1904. No. 60705 A.

Frequency Changers.

The Frequency Changers at Montreal. B. A. Behrend. Illustrates and discribes this plant and gives report of its power and efficiency. 1200 w. Elec Wld & Engr—Feb. 13, 1904. No. 60838.

Grounding.

Grounding of Constant Potential Systems. S. Bingham Hood. Illustrates the object of grounding a system and the requirements for safe operation, discussing conditions. 4200 w. Elec Wld & Engr—Feb. 20, 1904. No. 61026.

Rectifiers.

Rectifiers. Charles F. Burgess. Read at Milwaukee meeting of the Northwestern Elec. Assn. Briefly considers mechanical, vapor and electrolytic rectifiers and their efficiency. 2500 w. Elec Rev, N. Y.—Feb. 27, 1904. No. 61097.

The Electrolytic Rectifier and Interrupter. W. B. Churcher. Read before the Northwestern Elec. Assn. Describes the construction and mode of operation of these two inventions. 1500 w. Elec, N. Y.—Feb. 17, 1904. No. 60873.

Shipyards.

The Distribution of Electricity in Shipyards and Engine Works. J. A. Anderson. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. A description of the different means of applying electricity and some results obtained. 3000 w. Elec Engr, Lond—Feb. 12, 1904. No. 60886 A.

Trouble.

The Location of Trouble. George T. Hanchett. The article is confined to a discussion of the location of trouble in lines. 2300 w. Cent Sta—Feb., 1904. No. 60857.

ELECTRO-CHEMISTRY.

Batteries.

The Jungner Alkaline Battery. Claims that this battery antedates the Edison battery in several important particulars. Compares the two types. 1800 w. Auto Jour—Feb. 6, 1904. No. 60808 A.

The Transformation of Thermo-Chemical Energy into Voltaic Energy or Electromotive Force Dr. D. Tommasi. An account of investigations made by the writer with discussion of the results. 1200 w. Elec Rec, Lond—Jan. 22, 1904. No. 60612 A.

Commercial Products.

Electrochemical Industries. F. B. Crocker and M. Arendt. Considers electrolytic chemistry, electro-thermal chemistry, and chemical action due to electrical discharges. 6000 w. Sch of Mines Qr—Nov., 1903. No. 60832 D.

Electro-Metallurgical Works at La Praz. Illustrates and describes this interesting industrial concern near Grenoble, France, and the work carried on there. 800 w. Electro-Chem & Met—Jan., 1904. No. 60766 E.

Copper Wire.

Electrolytic Methods for the Production of Copper Wire. An illustrated article describing the various processes that different workers in this field have tried, although they have not proved commercially successful. 1200 w. Electro-Chem & Met—Jan., 1904. No. 60765 E.

Electro-Analysis.

Recent Electro-Analytic Methods (Neue Elektronalytische Behelfe). Dr. Heinrich Paweck. Describing especially the action of rotary electrodes and their uses in electrolytic work. 2000 w. Elektrochemische Zeitschr—Feb., 1904. No. 60974 G.

Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another. A. Hollard. Read before the Faraday Soc. Presents applications of the theory of electrolysis permitting of effectual analytical separations. 3500 w. Elec Rev, N Y—Feb. 27, 1904. No. 61099.

Gold.

Electrometallurgy of Gold in South Africa—1897 to 1899. Abstracts of papers bearing on this subject, aiming to give a review of the practice in South Africa. Also editorial. 13300 w. Elec-Chem Ind—Feb., 1904. No. 60651 C.

Ozone.

Recent Progress in the Ozone Industry (Les Progrès Récents Réalisés dan l'Industrie de l'Ozone). Marius Otto. A very full account of methods of generating ozone and of its application for sterilizing processes. 8000 w. 2 plates. Mem Soc

We supply copies of these articles. See page 157.

Ing Civ de France—Nov., 1903. No. 60-935 G.

Recent Progress.

Modern Discoveries in Chemistry. Dr. J. Ohly. Some notes on recent achievements in electro-chemistry made by Julius Walther, a young Russian. 2200 w. Min Rept—Jan. 28, 1904. No. 60539.

Review.

Electro-Metallurgy in 1903. A résumé of the year's progress, giving details of the industrial applications of the Vautin and Goldschmidt process for obtaining high temperatures, and of the electric steel processes. 2300 w. Engr, Lond—Jan. 29, 1904. Serial. 1st part. No. 60719 A.

Progress in Electro-Chemistry and Electro-Metallurgy in 1903. John B. C. Kershaw. A résumé of the progress giving details of processes and manufactures. 1300 w. Elec Rev, Lond—Feb. 5, 1904. Serial. 1st part. No. 60816 A.

Separation.

Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another. A. Hollard. A study of applications of the theory of electrolysis under the following headings: I. Reduction of the resistance of the bath by suppressing the formation of gas at the anodes; II. Influence of the nature of the kathode; III. Formation of complex salts. Ill. 3300 w. Electro-Chem & Met—Jan., 1904. No. 60764 E.

ELECTRO-PHYSICS.

Coil Windings.

Coil Windings for Electrical Purposes. Richard Varley and Charles R. Underhill. Read before the Northwestern Elec. Assn. A study of electromagnets and economy in winding. 3000 w. Elec Rev, N. Y.—Feb. 13, 1904. No. 60847.

Holtz Machines.

A Few Experiments with Holtz Machines. Samuel Sheldon. Abridged report presented to the Am. Electrotherapeutic Assn. A report of experimental trials, and what they appear to have established. 2300 w. Elec Rev, N. Y.—Feb. 13, 1904. No. 60845.

Insulation.

Bitumen in Insulating Compositions. Discussion of a paper by D. A. Sutherland on this subject. 2000 w. Electro-Chem & Met—Jan., 1904. No. 60763 E.

Magnet Windings.

Predetermining Magnet Windings. George W. Malcolm. An explanation of the method used by the writer. 1200 w. Am. Elect'n—Feb., 1904. No. 60594.

Radio-Activity.

A Résumé of Recent Progress in the Study of Radium and Radio-Activity. Information from recent articles in the technical press. 1800 w. Sci Am Sup—Feb. 20, 1904. No. 61054.

On the Properties of a Radioactive Gas Found in the Soil and Water Near New Haven. H. A. Bumstead and L. P. Wheeler. A report of investigations of these natural radio-active gases, concluding that they are apparently identical with the emanations from radium. 3600 w. Am Jour of Sci—Feb., 1904. No. 60527 D.

Radium. Prof. R. A. Milliken. Lecture at the convention of the Northwestern Electrical Assn. Reviews the earlier discoveries that led to the study of radio-active substances, and so to the discovery of radium, explaining its properties, etc. 1400 w. Elec, N. Y.—Feb. 3, 1904. Serial. 1st part. No. 60622.

Radium and Radioactivity (Le Radium et la Radioactivite). André Debierne. A description of the process of preparing radium from the ore, and an account of the phenomena which it displays. Two articles. 10000 w. Rev Gen des Sciences—Jan. 15, 30, 1904. No. 60911 each D.

Researches Relating to Radium. Frederick Soddy. Considers features of radium which need further inquiry,—especially the atomic weight. 2500 w. Nature—Jan. 28, 1904. No. 60694 A.

The Preparation and Properties of Radium (Le Radium. Preparation et Proprietes). Jacques Danne. An illustrated account, describing very fully the methods of detecting the presence of radium in minerals, and the complete chemical process of extraction. 3 articles. 7000 w. Génie Civil—Jan. 16, 23, 30, 1904. No. 60900 each D.

GENERATING STATIONS.

Alternators.

Applications of the Circle Diagram to Alternators (Anwendung des Kreisdiagramme auf Wechselstromgeneratoren). J. Puluj. Showing the general applicability of the diagram, originally designed by Heyland for the induction motor, to alternating-current dynamos. Two articles. 6000 w. Zeitschr f Elektrotechnik—Jan. 31, Feb. 7, 1904. No. 60971 each D.

The Excitation of Alternators. F. H. Davies. A discussion of methods of excitation. 3000 w. Elec Engr, Lond—Jan. 27, 1904. No. 60707 A.

Argentina.

The Power Plant of the Anglo-Argentina Tramway Company at Buenos Aires (Versuchs und Betriebsergebnisse an der Maschinenlage der Compania de Tramways Anglo-Argentina, Ltd., in Buenos Aires). Ad. Frei. A general description with load diagrams and indicator cards. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1904. No. 60922 D.

We supply copies of these articles. See page 157.

Armatures.

Some Practical Points in Armature Construction, Dealing Chiefly with Insulation. Hints of interest to those engaged in this class of work. Ill. 1800 w. Elec Engr, Lond—Jan. 22, 1904. No. 60611 A.

Cologne.

The Development of the Electric Stations of Cologne (Die Entwickelung der Cölner Elektricitätswerke). H. Overmann. Discussing especially the prices charged for current under the operation of a double-tariff system for different parts of the day. 5000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60957 B.

Eddy Currents.

Eddy Currents in Dynamo Machines. Michael B. Field. A discussion of Dr. Thornton's paper on this subject. 3800 w. Elect'n, Lond—Feb. 5, 1904. No. 60818 A.

Losses Due to Eddy Currents (Ueber Wirbelstromverluste). Dr. F. Niethammer. Discussing especially pole constructions intended to reduce eddy-current losses to a minimum. 2000 w. Zeitschr f Elektrotechnik—Jan. 24, 1904. No. 60969 D.

Enlargement.

New Installation at City of South Norwalk Electric Works. An illustrated description of the third enlargement within five years of this very successful municipal plant. 2200 w. Elec Wld & Engr—Feb. 20, 1904. No. 61028.

Fort Wayne.

The New Fort Wayne Electric Works. An illustrated description of the extensive improvements made to increase the capacity and facilities. 4000 w. Engr, U S A —Feb. 1, 1904. No. 60562 C.

Generating Sets.

Turbo-Dynamo Generating Sets (Turbodynamos). Dr. F. Niethammer. Discussing especially the construction of dynamos for high rotative speeds, adapted for direct-connection with steam turbines. Serial. Part I. 1800 w. Zeitschr f Elektrotechnik—Feb. 7, 1904. No. 60972 D.

Hydro-Electric.

High-Tension Hydroelectric Plants in Roumania and Switzerland. Frank C. Perkins. Illustrates and describes interesting features of some of these plants. 1600 w. Elec Rev, N Y—Feb. 27, 1904. No. 61098.

Power Development of the Toronto & Niagara Power Company. Illustrates and describes the general features and construction methods of this engineering work. 3700 w. Eng Rec—Feb. 13, 1904. No. 60778.

The Utilization of Hydro-Electric Power in Agricultural Work (Utilisation de l'Energie Hydro-Electrique dans les Installations Agricoles). A review of the circular of the Minister of Agriculture, calling attention to the advantages of electrical distribution of hydraulic power. 1500 w. Génie Civil—Jan. 30, 1904. No. 60904 D.

Location.

Application of Graphics to Power House Location. Sidney Diamant. Describes an ingenious graphical method of locating the electrical centroid of an area, where the position and intensity of the loads is known. 800 w. Elec Wld & Engr—Feb. 13, 1904. No. 60839.

Poles.

Auxiliary Poles for Continuous-Current Dynamos (Hilfspole für Gleichstrommaschinen). Franklin Punga. Showing that auxiliary poles and commutating fields are useful only in machines operating at high rotative speeds. 1800 w. Zeitschr f Elektrotechnik—Jan. 24, 1904. No. 60970 D.

Power Curves.

The Theoretical Determination of Power Curves. William J. Berry. A mathematical demonstration. 700 w. Elec Wld & Engr—Jan. 30, 1904. No. 60592.

LIGHTING.

Arc Lamps.

The Maximum Illuminating Power of Continuous-Current Arc Lamps in a Single Direction (Ueber das Relative Maximum Einseitiger Lichtausbente bei Gleichstrom-Bogenlampen). E. Richter. With diagrams showing the variation in light emitted for different angles of inclination of the carbons. 2000 w. Elektrotechnik Zeitschr—Feb. 4, 1904. No. 60962 B.

Incandescent Lamps.

Defects in Incandescent Lamps. E. Leavenworth Elliott. Gives a copy of a defect sheet of one of the large factories, all of which are supposed to be corrected before the lamp leaves the factory, and discusses defects that develop after use. 1300 w. Cent Sta—Feb., 1904. No. 60858.

The Incandescent Lamp. Brief review of the history of its development. 900 w. Elec Rev, N Y—Feb. 20, 1904. No. 61014.

Osmium.

The Efficiency and Color of Osmium Lamps. Prof. F. G. Baily. Gives results of a recent examination of these lamps, invented by Herr Auer von Welsbach. 900 w. Elect'n, Lond—Feb. 12, 1904. No. 60890 A.

The Osmium Lamp (Ueber die Osmiumlampe). L. Lombardi. Data and results of measurements of the temperature of the filament of the osmium incandescent lamp, and its relation to illuminating efficiency. 3000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60954 B.

We supply copies of these articles. See page 157.

Photometry.

The Photometry of Arc-Lamps. Paul F. Gaehr. Discusses the advantages of the arc-lamp photometer designed by Prof. C. P. Matthews. 1200 w. Sib Jour of Engng—Jan., 1904. No. 60738 C.

Single-Phase.

A Single-Phase Lighting-System in St. Louis. L. A. De Blois. An explanation of this system of the Missouri Edison Electric Co., and the conditions it is required to meet. 4500 w. Harvard Engng Jour—Jan., 1904. No. 60740 D.

Theatre Lighting.

The Electric Lighting of Drury Lane Theatre Royal. An illustrated review of the electric lighting arrangements, describing in detail recent improvements. 3300 w. Elect'n, Lond—Feb. 12, 1904. No. 60889 A.

MEASUREMENT.

Ampere Meter.

Multiple Ampere Meter (Vielstufige Strommesser). K. Feussner. Illustrating a convenient form of instrument, with seven resistances, rendering it available for various applications; the method of calibrating is described. 4000 w. Elektrotech Zeitschr—Feb. 11, 1904. No. 60966 B.

Capacity.

The Numerical Determination of the Capacity of Aerial Conductors and Cables (Ueber die Rechnerische Bestimmung der Kapacität von Luftleitern und Kabeln). Leo Lichtenstein. Giving formulas and diagrams and showing their applications to practical examples. Serial, Part I. 5000 w. Elektrotech Zeitschr—Feb. 11, 1904. No. 60965 B.

Magnetic Tests.

Magnetic Tests of Whole Sheets of Iron. Illustrates and describes apparatus on which whole sheets can be tested without any waste of material. 1000 w. Engng—Jan. 29, 1904. No. 60711 A.

Resonance.

The Precision and Operation of the Hartmann & Braun Resonance Instruments (Ueber Genauigkeit und Wirkungsweise der Hartmann & Braunschen Resonanzinstrumente). Dr. R. Hartmann-Kempf. Illustrating and describing instruments for measuring frequency and phase relations. 3000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60956 B.

Rheostats.

Liquid Rheostats (Ueber Flüssigkeitsanlasser). Dr. F. Niethammer. Discussing the effects of various arrangements of electrodes, and different kinds of electrolytes. 2000 w. Zeit f Elektrotechnik—Jan. 17, 1904. No. 60967 D.

Wattmeters.

Effects of the Wave-Forms on Measurements by the Two-Wattmeter Method. Abstract translation of article by Dr. L. Bloch, in *Elektrotech. Zeitschrift.* A discussion of the methods of measuring the effects of polyphase currents. 1200 w. Elec Engr, Lond—Feb. 12, 1904. No. 60885 A.

MOTORS.

Cascade System.

Cascade Operation of Motors for Rolling Mills (Kaskadenschaltungen bei Motoren für Walzwerke). E. Danielson. An account of the performance of induction motors operating rolling mill machinery at Näs, Delelfven, Sweden. A hydrostatic station of 2700 h. p. is included. 2000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60955 B.

Efficiency.

Determination of the Efficiency of a Galatti Asynchronous Motor (Determinazione di Rendiments di un Motore Asincrono Galatti). G. Sartori. Applying the Heyland circle diagram. 1200 w. L'Elettricita—Jan. 8, 1904. No. 60973 B.

Electric Power.

Providing the World with Power. Arthur Goodrich. On the great increase in the use of electricity, the factories where electrical devices are made, etc. 4500 w. World's Work—Feb., 1904. No. 60579 C.

Induction Motors.

On Asynchronous Motors. N. Pensabene. An explanation of a method more convenient than the Heyland diagram. Mathematical. 1100 w. Elec Engr, Lond—Feb. 12, 1904. No. 60887 A.

On the Magnetic Dispersion in Induction Motors, and Its Influence on the Design of These Machines. Dr. Hans Behn-Eschenburg. A description of theoretical and experimental researches communicated to the Institution of Electrical Engineers through Prof. S. P. Thompson. 2800 w. Elect'n, Lond—Jan. 22, 1904. Serial. 1st part. No. 60613 A.

Magnetic Brake.

Magnetic Brake for Small Electric Motors. Illustrates and describes two types devised by Siemens & Halske, explaining the principle of their action. 900 w. Sci Am—Feb. 20, 1904. No. 61051.

Mine Power.

See Mining and Metallurgy, Mining.

Motor Diagram.

The Circle Diagram of the Induction Motor (Das Kreisdiagramm des Mehrphasenmotors). A. Heyland. A communication regarding the question of priority of use of the diagram, with some examples of its application. 1800 w. Elektrotech Zeitschr—Jan. 21. 1904. No. 60958 B.

We supply copies of these articles. See page 157.

Pendulum Systems.

Electrical Foucault Pendulum Systems. Ernest K. Adams. Considers various electromagnetic pendulums, and suggests ingenious electric expedients for maintaining the amplitude of vibration. Ill. 5200 w. Elec Wld & Engr—Jan. 30, 1904. No. 60591.

Printing Office.

Mechanical and Electrical Equipment of the Sackett & Wilhelms Lithographing and Printing Company. An illustrated description of the building and plant, which shows many unique features. 2000 w. Elec Rev, N Y—Feb. 6, 1904. Serial. 1st part. No. 60661.

Repulsion Motor.

On the Circle-Diagram of the Repulsion Motor. F. Creedy. Containing a general method of deducing the graphic theory of any alternating current apparatus. 1200 w. Elec Rev, Lond—Feb. 5, 1904. Serial. 1st part. No. 60813 A.

Series Motor.

The Alternating-Current Series Motor. F. D. Newbury. A detailed explanation of its operation. 2000 w. Elec Rev, N Y—Feb. 6, 1904. No. 60660.

Single-Phase Motor.

British Lamme Single-Phase Railway Motor Patent. Reprint of the full specification of the British patent granted to B. G. Lamme, with drawings. 5000 w. Elec Wld & Engr—Feb. 13, 1904. No. 60840.

Discussion on A. I. E. E. Papers on the Single-Phase Railway Motor. Discussion in full by Messrs. Lamme, Steinmetz and Armstrong, and the non-mathematical part of the remarks of Prof. A. S. McAllister. 8000 w. Elec Wld & Engr—Feb. 13, 1904. No. 60841.

The Regulation of Single Phase Commutator Motors (Einphasenkollektormotoren und ihre Regelung). Friedrich Eichberg. A mathematical discussion, with numerous diagrams referring especially to the motor designed by the author and Herr Winter. 5000 w. Elektrotech Zeitschr—Jan. 28, 1904. No. 60960 B.

TRANSMISSION.

High-Voltage.

European Practice in the Construction and Operation of High-Pressure Transmission Lines and Insulators. Guido Semenza. Illustrated descriptions of iron poles, insulators, etc. 4500 w. Trans Am Inst of Elec Engrs—Feb. 26, 1904. No. 61062 D.

The Conductivity of the Atmosphere at High Voltages. Prof. Harris J. Ryan. Paper before the American Inst. of Elect. Engrs., giving an analysis of the factors that produce the energy losses through the atmosphere on high-voltage lines, with account of laboratory experiments and diagrams. 8800 w. Trans Am Inst of Elec Engrs—Feb. 26, 1904. No. 61061 D.

Leakage.

The Measurement of Distributed Leakage on Transmission Lines. Frank F. Fowle. Describes methods of measuring insulation resistance. Mathematical. 2000 w. Elec Wld & Engr—Feb. 6, 1904. No. 60689.

Long Distance.

The American River Electric Company's Plant on the South Fork of the American River. Illustrates and describes a model plant recently completed in Central California. Power is transmitted to Stockton, eighty miles, and to Folsom, thirty miles further. 3300 w. Jour of Elec —Feb., 1904. No. 60836 C.

Transformers.

Ordinary Transformer Connections. William H. Kritzer. Explanations with diagrams. 700 w. Min & Sci Pr.—Feb. 6, 1904. No. 60867.

MISCELLANY.

Electric Inventions.

The Relation of Electric Inventions to Human Activity. Dr. Louis Bell. A review of the fundamental electrical inventions, including the telegraph, telephone, dynamo, motor, incandescent lamp, etc., showing their nature as labor-saving appliances. 3000 w. Engineering Magazine —March, 1904. No. 60993.

Germany.

A Study of the Electrical Industry in Germany (Etude sur l'Industrie Electrique Allemande). L. Sekutowicz. A full review of the development of the industry of electrical machinery and the operation of plants, with a discussion of recent business reorganizations. 10,000 w. Mem Soc Ing Civ de France—Dec., 1903. No. 60937G.

GAS WORKS ENGINEERING

Acetylene.

Dissolved Acetylene and Its Applications (L'Acétylène Dissous et ses Principales Applications). F. Bourdil. Describing the Fouché modification of the method of Claude and Hess for dissolving acetylene in acetone and rendering it safe for transportation. Applications to train light-

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ing, blowpipe, etc., are given. 2000 w. Mem Soc Ing Civ de France—Nov., 1903. No. 60934 G.

Specifications for an Acetylene Gas Generating Apparatus for Fort McPherson, Ga. Gives specifications in full, omitting the "General Conditions." 1800 w. Eng News—Feb. 4, 1904. No. 60675.

Ammonia.

A Few Notes on Ammonia. F. E. Sheriff. Read before the Michigan Gas Assn. Considers the recovery from the gases obtained by the carbonization of bituminous coal. 2000 w. Am Gas Lgt Jour—Feb. 22, 1904. No. 61008.

Benches.

Care of Benches and Results Therefrom. T. J. Whalen. Read at meeting of Michigan Gas Assn. Considers causes of poor results and some of the troubles in retort houses. 5500 w. Am Gas Lgt Jour—Feb. 22, 1904. No. 61007.

Gas Producer.

The Deschamps Down Draft Gas Producer. Translation from an article in the *Bulletin de la Société de l'Industrie Minerale*, by Jules Deschamps, concerning an invention for the purpose of producing a gas of the most suitable composition for use in gas engines. Ill. 2500 w. Ir Age—Feb. 4, 1904. No. 60603.

Retorts.

Inclined Retorts at Chesterfield. An illustrated description of a new installation, with brief account of these works. 3000 w. Gas Wld—Feb. 13, 1904. No. 60883 A.

Small Works.

The Construction and Operation of Small Gas-Works in Germany. Dr. E. Schilling. From a lecture delivered before the Bavarian Union of Gas and Water Engrs., at Munich. Gives information regarding the cost of various kinds of plants, and the progress in the consumption of illuminating gas. 3800 w. Pro Age—Feb. 1, 1904. No. 60533.

Water Gas.

The Kramer and Aarts Water-Gas Process. Dr. Alph. Steger. Read before the German Gas Assn. Summary. Describes methods of making blue water gas. Claims efficiency under test of 85 per cent. Discussion. Ill. 3300 w. Gas Wld—Jan. 30, 1904. No. 60704 A.

The Principal Applications of Water Gas (Le Gaz à l'Eau et ses Principales Applications). E. Demenge. With especial reference to the Dellwik-Fleischer process, and to the industrial uses of water gas, such as heating, welding, etc. 4000 w. Rev Gen des Sciences—Jan. 30, 1904. No. 60913 D.

Water Gas. Prof. A. Humboldt Sexton. Describes various plants and their method of working. Ill. 4500 w. Mech Engr—Feb. 13, 1904. Serial. 1st part. No. 60875 A.

INDUSTRIAL ECONOMY

Cost Keeping.

A Card Index System for Obtaining the Cost and Distribution of the Non-Productive Labor. George P. Pearce. An explanation of a system of the writer's, which is for all practical purposes, accurate. 2300 w. Am Mach—Feb. 11, 1904. No. 60776.

See also Mechanical Engineering, Machine Works and Foundries.

Education.

Nautical Education in Japan. Facts of interest from the prospectus of the Nautical College at Tokio, showing the provision made for the scientific training of officers and men. 1500 w. Nature—Feb. 4, 1904. No. 60801 A.

Oxford and Science. Dr. John Perry. An address discussing the neglect of scientific training at the English universities, and its importance upon the international position of the country in political and commercial matters. 7500 w. Nature—Dec. 31, 1903. No. 60995 D.

Technical Education in Germany. Max Wurl. An explanation of the educational system in the German empire, followed by discussion. 10800 w. Trans N E Coast Inst of Engrs & Shipbldrs—Jan., 1904. No. 60755 D.

Technical Instruction in Germany. W. G. Rhodes. Discusses German methods, comparing them with English instruction. Confined to courses in electrical engineering. 1800 w. Elec Rev, Lond—Feb. 12, 1904. No. 60888 A.

Technical Education in the United States (Der Technische Schulunterricht in den Vereinigten Staaten). P. Kreuzpointner. A review of the curricula and methods of American technical schools by a German engineer resident in the United States. 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1904. No. 60918 D.

The Mathematical Training of Engineers. R. Howard Duncan. A discussion of the training needed by a professional engineer, considering the usual training given in mathematics and how it may be improved. 2000 w. Prac Engr—Jan. 29, 1904. Serial. 1st part. No. 60703 A.

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Transatlantic Engineering Schools and Engineering. R. Mullineux Walmsley. On the educational methods and training adopted in the United States, as viewed during a recent trip of inspection, and a discussion of applications to Great Britain. 18300 w. Inst of Elec Engrs—Feb. 11, 1904. No. 60884 D.

What Inducements to Enter "Light Current Engineering" Are Held Out to Technical Students. Joseph B. Baker. Explains what is meant by "light current engineering," and discusses the fields of telephony, telegraphy, and wireless telegraphy. 1600 w. Elec Rev, N Y—Feb. 13, 1904. No. 60844.

Invention.

"Invention." Editorial review of an address by J. Fletcher Moulton as President of the Junior Inst. of Engrs. 2000 w. Engng—Jan. 29, 1904. No. 60715 A.

Presidential Address before the Junior Institution of Engineers. J. Fletcher Moulton. Abstract of a valuable address on invention, the equipment of the inventor, the aims, etc. 6000 w. Engr, Lond—Jan. 29, 1904. No. 60721 A.

Relation of Employer and Employee in Reference to Inventions. Grafton L. McGill. Read before the Modern Science Club of Brooklyn, N. Y. Discusses various classes of relations between employer and employee and the doctrines tending to the general welfare. 2800 w. Am Mach—Feb. 4, 1904. No. 60639.

Labor.

Reconciling the Conflict Between Employers and Employees. Ralph M. Easley. Discusses the questions lying back of industrial disturbances, and the outlook. 4400 w. Bankers' Mag, N Y—Feb., 1904. No. 60727 C.

The Denaby Main Case. Summary of facts and decision, with editorial, in this case where employers have successfully held the Union responsible for damages during an illegal strike. 5000 w. Engr, Lond—Feb. 12, 1904. No. 61000 A.

Trade Unions and Employers' Associations. Charles W. Eliot. From an address to the Boston Central Labor Union. A review of the principles which govern the relations between employers and employees, and of the past history and present methods. 4500 w. R R Gaz—Feb. 12, 1904. No. 60796.

Labor-Saving.

The World's Great Labor Savers and Labor Servers. Robert W. Hunt. A review of the work which has been done by the great inventors and engineers of the past century, with numerous portraits. 3500 w. Engineering Magazine—March, 1904. No. 60986 B.

Machinery.

The Effects of Labor-Saving Machinery. Frank H. Rose. A conservative view of the effect of machinery upon the wage earner, showing the result to be beneficial to employer and employee. 4000 w. Engineering Magazine—March, 1904. No. 60987 B.

Metallurgical Industries.

The Decline of Metallurgical Enterprise in England. Henry F. Collins. A review of the causes that explain the decline of all metallurgical industries with the exception of iron and steel. 2800 w. Eng & Min Jour—Feb. 4, 1904. No. 60653.

Patents.

Patents Which Obstruct. George W. Dickie. Read before the Tech. Soc. of the Pacific Coast, (Condensed). A discussion of patents and the kind of patent business that is objectionable, giving illustrations of cases. 4500 w. Am Mach—Feb. 4, 1904. No. 60638.

Premium Plan.

A German View of the Premium Plan. B. Schiller. Abstract of a paper published in the *Zeitschrift des Vereines Deutscher Ingenieure.* A critical examination of the advantages and disadvantages of the various modifications of the Halsey premium plan of rewarding labor. 2500 w. Am Mach—Feb. 18, 1904. Serial. 1st part. No. 60850.

Syndicates.

The German Coal Cartel and Its Renewal. Francis Walker. The plan of organization and the results accomplished by the coal and coke syndicates. 7500 w. Mines & Min—Feb., 1904. Serial. 1st part. No. 60627 C.

MARINE AND NAVAL ENGINEERING

Breakdown.

The Accident on H. M. S. "Bullfinch." Gives the evidence relating to the dimensions of the jaw of the connecting-rod which fractured and caused the disaster, and the magnitude of the forces producing the stress under which the fracture took place. Ills. 2500 w. Engng—Feb. 5, 1904. No. 60825 A.

British Shipping.

Free Trade and British Shipping. W. H. Renwick. Discusses the restrictions

imposed by Parliament, and compares with foreign competition; considers subsidies and other matters affecting the shipping interests. 6000 w. Nineteenth Cent—Feb., 1904. No. 60870 D.

Cable Steamer.

The Cable-Laying Steamer Stephan (Le Stephan, Navire Poseur de Cables). Illustrated description of the new vessel of the German cable company, used for laying the second line via the Azores to New York. 1500 w. 1 plate. Génie Civil—Jan. 30, 1904. No. 60903 D.

Coaling Plant.

Frenchman's Bay Coaling Plant. Illustrated description of this naval coal depot on the Maine coast. 3700 w. Eng Rec—Jan. 30, 1904. No. 60552.

Cruisers.

The Japanese Cruisers "Kasuga" and "Nisshin." Illustrated description of the two cruisers purchased from the Argentine Government by Japan. 600 w. Engng—Jan. 22, 1904. No. 60616 A.

The Military Capabilities of Cruisers (La Guerra di Crociera). Romeo Bernotti. An examination of the strength and weakness of high-speed cruisers in modern naval warfare. 10000 w. Rivista Marittima—Jan., 1904. No. 60948 H.

Ferryboat.

New Screw Ferryboat. Illustration with details of the boat which is to be used in the immigration transfer service at the port of New York. 1000 w. Naut Gaz—Feb. 4, 1904. No. 60659.

Fishing Steamer.

Norwegian Fishing Steamer. Illustrations and description of the latest type of smaller 75-foot fishing steamers used on the north and west coasts of Norway. 1200 w. Marine Engng—Feb., 1904. No. 60646 C.

Fleets.

The Japanese and Russian Fleets. Reviews the naval strength of the two countries. 1800 w. Engr, Lond—Feb. 12, 1904. No. 61001 A.

The War Fleets of Japan and Russia. Archibald S. Hurd. An illustrated review giving much information of interest. 8400 w. Cassier's Mag—Feb., 1904. No. 61067 B.

Floating Dock.

The New Off-Shore Floating Dock for the Reiherstieg Schiffswerfte und Maschinenfabrik, Hamburg. Two-page plate with description. 1200 w. Engng—Feb. 12, 1904. No. 60895 A.

Ice-Breakers.

Ice-Breakers and Their Services. Arthur Gulston. Deals with vessels that work among ice that is formed from year to year, illustrating and describing types. Discussion. 9000 w. Jour Soc of Arts—Jan. 29, 1904. No. 60696 A.

Launching.

Launching an Armored Cruiser. Data in connection with the launch of the first-class armored cruiser Roxburgh. 900 w. Engng—Jan. 29, 1904. No. 60716 A.

Motor Boats.

First National Motor Boat Show. Illustrations and descriptive notes on the gasoline launches and engines displayed at Herald Square Exhibition Hall, New York. 2000 w. Automobile—Feb. 20, 1904. No. 61050.

Naval Station.

The New Admiralty Works at Dover. Illustrated description of a future British naval station. 800 w. Page's Mag—Feb., 1904. No. 61073 B.

Navy.

The Japanese Navy. A review of this modern navy, with many illustrations. 3300 w. Sci Am—Feb. 13, 1904. No. 60799.

The Russian Navy. Gives the leading particulars of Russia's battleships, so far as known, illustrating many of them. 2700 w. Sci Am—Feb. 20, 1904. No. 61052.

Neutral Vessels.

Neutral Vessels in War Time. Editorial discussion of some of the principles of international law which apply for the protection of neutral vessels. 2200 w. Engng—Jan. 22, 1904. No. 60617 A.

Propellers.

An Inquiry Regarding the Marine Propeller. J. Millen Adam. An endeavor to concentrate the attention on the propeller and the fluid which passes through it, as a conservative system in the sense indicated by an illustration from the art of ropemaking. Ills. 5400 w. Trans Inst of Engrs & Shipbldrs in Scotland—Vol. 47, Part III. No. 60732 D.

Marine Propellers with Non-Reversible Engines and Internal Combustion Engines. Discussion of Mr. Rankin Kennedy's paper on this subject. Ill. 4300 w. Trans Inst of Engrs & Shipbldrs in Scotland—Vol. 47, Part III. No. 60731 D.

Schooners.

American Coasting Schooners. Illustration, plans and details of the Dorothy Palmer, one of the latest and best of the wooden types. 1700 w. Naut Gaz—Feb. 18, 1904. No. 60899.

Speed.

On the Extreme Cost of High Speed. Sidney Graves Koon. Discusses the cost of power for the required speed in the case of steamships. 1300 w. Sib Jour of Engng—Jan., 1904. No. 60739 C.

We supply copies of these articles. See page 157.

The Influence of Depth of Immersion Upon Speed (De l'Influence de la Surimmersion sur la Vitesse). J. A. Normand. Developing formulas for computing the effect of changes in draught upon the speed of vessels. 2000 w. Comptes Rendus—Dec. 28, 1903. No. 60929 D.

Steamer.

Twin-Screw Steamer "Corona" for Northern Nigeria. Illustrated description of vessel of galvanized steel, built on the tunnel principle, for service as a yacht. 1,000 w. Engng—Jan. 29, 1904. No. 60714 A.

Torpedoes.

Attack and Defense of Coasts by Means of Torpedoes (Attaque et Défense des Côtes au Moyen des Torpilles). H. Noalhat. The first installment of a serial dealing with design and construction of automobile torpedoes. Serial. Part I. 3500 w. Revue Technique—Jan. 10, 1904. No. 60908 D.

Vibration.

The Torsional Vibration of Screw Propeller Shafts (Vibrazioni Torsionali degli Alberi delle Macchine Marine). Pietro Enrico Brunelli. An examination of the influence of the torsion of the shaft of a marine engine upon the period of vibration of the machinery. 4000 w. 1 plate. Rivista Marittima—Jan., 1904. No. 60949 H.

Wrecks.

Drouillard's Drifter Balloon Float. Describes an ingenious apparatus used to carry a rope between a vessel in distress and the land. 800 w. U S Cons Repts—Feb., 1904. No. 60722 D.

Yachts.

The Laying Up and Storing of Small Yachts for Winter. Frederic S. Nock. Explains methods of hauling out of the water, stripping the rigging, and other points necessary to properly protect the vessel. 1500 w. Marine Engng—Feb., 1904. No. 60648 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Achilles.

The 1904 Achilles Petrol Cars. Illustrates and describes these cars, built in English works, and intended for "men of moderate means." 2000 w. Auto Jour—Feb. 13, 1904. No. 60878 A.

Carburettor.

The Automatic Carburettor on the Crossley Car. Illustrated description. 1500 w. Auto Jour—Feb. 13, 1904. No. 60880 A.

Chenard-Walcker.

The 18 H. P. Chenard and Walcker Car. Illustrated description of the interesting features. 1400 w. Autocar—Jan. 23, 1904. No. 60604 A.

The 1904 Chenard and Walcker Petrol Cars. An illustrated detailed description of these vehicles. 3000 w. Auto Jour—Jan. 23, 1904. No. 60606 A.

Chicago Exhibits.

Some Novel Western Cars Exhibited. Illustrates and describes interesting cars shown at Chicago. 3000 w. Automobile—Feb. 13, 1904. No. 60772.

Closed Cars.

Closed Automobile Bodies—Their Development and Present Styles. Illustrations and brief descriptions of interesting types. 2000 w. Automobile—Feb. 13, 1904. No. 60773.

Crossley.

Some Further Details of the Crossley Petrol Car. Illustrations with description of features of interest. 1800 w. Auto Jour—Feb. 6, 1904. No. 60807 A.

The "Crossley" Petrol Motor-Car. Illustrates and describes a car which aims to be second to none in quietness and steadiness of running, durability and reliability. 2200 w. Motor-Car Jour—Jan. 30, 1904. No. 60695 A.

Daimler.

The Daimler Motor Company. An illustrated account of the work of this company in automobile construction, describing the methods. 4700 w. Trac & Trans—Feb., 1904. No. 60819 E.

Exhibitions.

Automobilism at the Salon of December, 1903 (L'Automobilisme au Salon de Décembre 1903). Gérard Lavergne. A brief review of the recent exhibition in Paris, showing broadly the progress there displayed. 2000 w. Rev Gen des Sciences—Jan. 15, 1904. No. 60912 D.

Interesting and Novel Features of Car Construction at the Madison Square Show. H. L. Towle. Remarks on features of interest observed at the recent exhibition in New York. 2000 w. Automobile—Jan. 30, 1904. No. 60534.

Show Hints for Intending Buyers. Rene M. Petard. Begins an illustrated discussion of the vital parts of car construction. 2400 w. Automobile—Jan. 30, 1904. No. 60535.

Show Tendencies in Construction. Hugh Dolnar. A brief discussion of the recent exhibition in New York and the

We supply copies of these articles. See page 157.

types predominating. 1700 w. Automobile—Jan. 30, 1904. No. 60536.

Society of Motor Manufacturers' Exhibition at the Crystal Palace. Illustrated descriptions of interesting exhibits. 3500 w. Auto Jour—Feb. 13, 1904. No. 60881 A.

Fire Engine.

Automobile Fire Engine (Pompe à Incendie Automobile). F. Drouin. An illustrated account of the Weyher & Richemond automobile steam fire engine as shown at the recent exhibition in Paris. 1800 w. 1 plate. Génie Civil—Feb. 6, 1904. No. 60905 D.

Germain.

The Germain Standard Car. Illustrated detailed description. 1000 w. Autocar—Jan. 30, 1904. No. 60709 A.

The 1904 Germain Petrol Cars. An illustrated description of a 16-h. p. vehicle made by these Belgium manufacturers. 2500 w. Auto Jour—Feb. 13, 1904. No. 60877 A.

Legislation.

The Motor Car Act and Regulations. W. Valentine Ball. Deals with the provisions of the English Motor Car Act, 1903, and the regulations made under it, with a view to showing in what respects the law has been modified. 5000 w. Trac & Trans—Feb., 1904. No. 60820 E.

Mieusset.

The Mieusset Petrol Cars. Illustrated description of cars built in Lyons, France. 2500 w. Auto Jour—Feb. 6, 1904. No. 60806 A.

Oldsmobile.

The 1904 Oldsmobile. Illustrates and describes this car, which is simple in construction, easily managed and quiet running. 1200 w. Autocar—Feb. 6, 1904. No. 60809 A.

Pedrail.

Recent Developments of the Pedrail. Gives reasons why it is believed this system will come into general use, and explains the principles on which its construction is based. Ill. 3000 w. Auto Jour—Jan. 23, 1904. Serial. 1st part. No. 60607 A.

Pope-Toledo.

The 24 Horse-Power Pope-Toledo Touring Car. Illustrated detailed description of the 1904 model gasoline touring car. 1200 w. Sci Am—Jan. 30, 1904. No. 60570.

Railway Vehicles.

See Railway Engineering, Motive Power and Equipment.

Review.

The Progress of Automobilism in 1903 (Les Progrès de l'Automobilisme en 1903). F. Drouin. A review of improvements in details of construction during the year, chiefly shown in the exhibitions. 3 articles. 6,000 w. Génie Civil—Jan. 16, 23, 30, 1904. No. 60901 each D.

Richard.

Georges Richard-Brazier Cars. Illustrates and describes a popular type of car made in four powers, of almost identical design. 1000 w. Autocar—Feb. 13, 1904. No. 60876 A.

Road Train.

A New System of Continuously Propelled Road Trains (Sur un Nouveau Système de Train Routier Dit à Propulsion Continue). Ch. Renard. An account of the Renard system of automobile road trains, showing especially the method of steering. 1200 w. Comptes Rendus—Dec. 28, 1903. No. 60930 D.

Ryknield.

The Ryknield Cars. Illustrates and describes some of the leading features of these cars. 800 w. Autocar—Feb. 6, 1904. No. 60811 A.

Siddeley.

The Siddeley Petrol Cars. Brief illustrated description of the latest design built for this company. 800 w. Auto Jour—Feb. 13, 1904. No. 60882 A.

Steam Cars.

Steam Cars for Public Service. Thomas Clarkson. Presents the necessity for superseding horse traction by mechanical means and discusses the principles of construction in such vehicles and the claims of the steam car. General discussion. 7400 w. Jour Soc of Arts—Feb. 5, 1904. No. 60802 A.

Steering.

Steering Gears: Their Principles and Action. A critical discussion of the "single pivot" or "fifth wheel" type, showing that it is not suitable for motor vehicles. 1200 w. Autocar—Jan. 23, 1904. No. 60605 A.

Thomas.

The Thomas Triple-Cylinder Touring Car. Illustrated detailed description. 2000 w. Sci Am—Jan. 30, 1904. No. 60571.

Upkeep.

The Cost, Care and Upkeep of a Motor Car. A paper by Dr. Gilpin, read before the Lincolnshire Auto. Club. 2000 w. Autocar—Feb. 6, 1904. No. 60810 A.

Western Cars.

Features of New Western Cars. Calls attention to new and interesting features as shown in the cars at the Chicago exhibition. 4000 w. Automobile—Feb. 20, 1904. No. 61049.

See also Mechanical Engineering, Internal-Combustion Motors.

We supply copies of these articles. See page 157.

HEATING AND COOLING.

Absorption Process.

Recent Absorption Refrigerating Machines (Nouvelles Machines Frigorifiques à Affinité). J. Hignette. Describing the Larrieu & Bernat machine, recently installed at Grenelle, Paris. 2000 w. Mem Soc Ing Civ de France—Dec., 1903. No. 60936 G.

Central Plants.

Central Station Heating. W. H. Schott. Read before the Northwestern Elec. Assn. Discusses things necessary if heating from central stations is to prove successful and profitable. 3200 w. Elec Rev, N Y—Feb. 13, 1904. No. 60846.

Foundations.

Foundations for Ice Machines. T. R. Wingrove. First of a series of articles on erecting and operating refrigerating machines; discusses preparing for and building suitable foundations. 2400 w. Ice & Refrig—Feb., 1904. Serial. 1st part. No. 60654 C.

Hot-Water.

Description of the Hot-Water Heating Apparatus in the Schioldann Institution, Copenhagen, Denmark. A. B. Reck. Read at N. Y. meeting of the Am. Soc. of Heat. & Ven. Engrs. Explains the climate and conditions in Denmark and describes the method of heating employed. Short discussion. 5500 w. Met Work—Jan. 30, 1904. No. 60524.

Public Schools.

Warming and Ventilating of Public Schools. From a paper by D. M. Nesbit, read before the Com. on Hygiene, San. Inst. Cong., Bradford, Eng. Suggestions for small, medium sized and large schools. 1200 w. Dom Engng—Jan. 25, 1904. No. 60538 C.

Radiation.

Radiation or Pipe Surface Required for Greenhouses and for Ordinary Buildings Having Considerable Variations in Construction, Size and Temperature. Walter Jones. Read at London meeting of the Inst. of Heat. & Ven. Engrs. Condensed paper containing technical information. 1400 w. Dom Engng—Jan. 25, 1904. No. 60537 C.

Steam Heating.

Steam Heating from a Central Station. F. B. Hofft. Read before the Indiana Engng. Soc. Particularly describing the plant of the Merchants' Heat and Light Company of Indianapolis, and its operation. Considers the system nearly ideal. 2000 w. Munic Engng—Feb., 1904. No. 60751 C.

Vacuum Process.

Ice Making by the Vacuum Process. Edward A. Osse. Illustrated description of machinery and process used. 1200 w. Ice & Refrig—Feb., 1904. No. 60655 C.

HYDRAULICS.

Connecticut.

A New Water Power Development at New Milford, Connecticut. Walter Scott Morton. Begins an interesting illustrated account of the development of the Bull's Bridge plant. 2300 w. Eng Rec—Feb. 13, 1904. Serial. 1st part. No. 60780.

High-Pressure Power on the Housatonic. Illustrates and describes the Bull's Bridge power plant on the Housatonic River, which differs from usual eastern practice. 3300 w. Elec Wld & Engr—Feb. 13, 1904. No. 60837.

Hydraulic Machinery.

Hydraulic Power Appliances in Engineering Industries. George H. Baxter. Especially discussing hydraulic transmission, cranes, hoisting machinery, dock and harbor appliances. Serial. Part I. 5000 w. Engineering Magazine—March, 1904. No. 60990 B.

Water Power.

A Low-Head Mill Power at Juliette, Ga. Plan and description of the water-power development. 1500 w. Eng Rec.—Feb. 6, 1904. No. 60667.

Wharf Installation.

Hydraulic Crane at the Tower Wharf of the General Steam Navigation Company. Illustrations and brief description of an installation consisting of seven hydraulic jib-cranes. 800 w. Engng—Feb. 12, 1904. No. 60896 A.

MACHINE WORKS AND FOUNDRIES.

Can Making.

Niagara Automatic Can Body Machine. Illustrated description of an invention of Edmund Zeb which promises an output of 30,000 cans a day. 2500 w. Ir Age—Feb. 18, 1904. No. 60859.

Chains.

The Evolution of the Chain. J. Hartley Wicksteed. Traces its history from the earliest times, discussing its modern developments. Fully illustrated. 6000 w. Page's Mag—Feb., 1904. No. 61072 B.

Cost Keeping.

See Industrial Economy.

Crane.

A Special Form of Electric Travelling Crane (Elektrisch Betriebener Spezial-laufkran). A. Dondelinger. Illustrating a travelling ladle crane made for the Chatillon-Commentry works in connection with its basic steel plant. 2000 w. Stahl u Eisen—Jan. 1, 1904. No. 60978 D.

Crank Pins.

Capitaine's Crank-Pin Turning Ma-

chine. Illustrations with brief description. 600 w. Engng—Feb. 12, 1904. No 60894 A.

Crucibles.

Crucible Furnaces for Foundry Work (Tiegelöfen im Giessereibetriebe). C. Inesberger. Showing recent forms of crucible furnaces for making brass, bronze, gray-iron and steel castings. Serial. Part I. 3000 w. Stahl. u Eisen—Feb. 1, 1904. No. 60984. D

Cupolas.

Notes on Cupolas and Cast Iron. C. Morehead. Read before the Rugby Engng. Soc. Discusses things bearing on the melting and mixing of iron, temperatures, blast pressures, etc. 4500 w. Prac Engr—Jan. 29, 1904. No. 60701 A.

Dies.

Forging-Machine Dies. Thomas Beasley. Illustrates and describes the making of a number of dies. 1200 w. Am Mach—Feb. 18, 1904. No. 60851.

The Making of a Sub-Die and Punch. F. B. Burnham Describes a method which the writer has proved successful. 1200 w. Ir Trd Rev—Feb. 4, 1904. No. 60658.

Drawing Office.

The Group Drawing Office System. Walter Ferris. Describes this system as used by the Bucyrus Company. 3400 w. Am Mach—Jan. 28, 1904. No. 60548.

Forging Press.

An Austrian Steam-Hydraulic Forging Press. Illustrates and describes a 1200-ton forging press which consists of a steam-hydraulic intensifier and press proper. 600 w. Sci Am Sup—Jan. 30, 1904. No. 60575.

Foundry.

A Modern Jobbing Foundry. An illustrated detailed description of the plant of the Buffalo Foundry Co. 2200 w. Foundry —Feb., 1904. No. 60530.

Foundry Costs.

Foundry Costs: Their Analysis and Reduction. Henry Hess. Outlines a successfully used method of cost analysis. Discussion. 4000 w. Pro Engrs' Club of Phila —Jan., 1904. No. 60760 D.

Foundry Machinery.

Labor Saving Machinery in Foundry Operations. Dr. R. Moldenke. A fully illustrated account of the latest improvements in cranes, ladles, moulding machines, conveyors, core machines, and other appliances. 3500 w. Engineering Magazine—March, 1904. No. 60991 B.

Gear Blanks.

Machinery Gear Blanks in the Lathe. Frank B. Kleinhans. An illustrated description of a lathe fitted with a turret drilling attachment and its use. 600 w. Am. Mach—Jan. 28, 1904. No. 60550.

Grinder.

An Electric Grinder. F. C. Mason. Illustrated description of an electric grinding machine, designed and built by the writer, which has given satisfaction. 1000 w. Am Mach—Feb. 18, 1904. No. 60853.

Hardening.

Hardening Machine Tool Parts. John Randal. Illustrates and describes the methods used in the Sloan & Chace shops, Newark, N. J. 1000 w. Am Mach—Feb. 25, 1904. No. 61077.

Individual Driving.

Motor-Driven Machine Tools. Explains the conditions to be considered when arranging for a planing machine drive. Ill. 2200 w. Am Engr & R R Jour—Feb., 1904. No. 60590 C.

The Individual Application of Electric Motors to Machinery, with Rules for Determining the Size of Motors. William Cooper. Calls attention to points of importance if these motors are to give satisfaction, illustrating by cases, and gives rules for determining sizes. 3500 w. Cassier's Mag—Feb., 1904. No. 61071 B.

Jigs.

Jig for Drilling and Milling. C. T. Sutton. Illustrated description of a jig adapted to any ordinary high-speed lathe at slight cost. 900 w. Engr, Lond—Feb. 12, 1904. No. 61006 A.

Lathes.

Special Lathe for Recessing Small Shafts. H. Robinson. Line drawings with brief description. 350 w. Am Mach—Feb. 11, 1904. No. 60777.

The Putnam 90-Inch Driving Wheel Lathe. Illustrated description of one of the most powerful locomotive driving wheel lathes ever built. 1700 w. Ir Age—Feb. 11, 1904. No. 60692.

Lifts.

Factory Schemes—Three Special Lifts. S. A. Worcester. Illustrates and describes three lifts designed for special work. 1200 w. Am Mach—Feb. 18, 1904. No. 60852.

Link Motion.

Who Really Invented the Link Motion. W. L. Campbell. Presents facts in proof of the claim that Williams, and not Howe, invented the link motion. 4000 w. Am Mach—Feb. 11, 1904. No. 60775.

Machine Driving.

Electric Power in Tanneries. George E. Walsh. An illustrated description of what has been accomplished in utilizing electricity for the operation of tanneries. 1700 w. Elec Rev, N Y—Feb. 20, 1904. No. 61016.

Modern Methods of Operating Machine Tools Electrically. General text of a lecture by Putnam A. Bates before the

We supply copies of these articles. See page 157.

Engng. Soc. of Columbia Univ. Considers the methods of electric distribution and the arrangements of the motors. 2500 w. Elec Wld & Engr—Feb. 13, 1904. No. 60842.

The Electric Driving of Machinery in Shops of the Austrian State Railways at Linz (Der Elektrische Betrieb in den k. k. Staatsbahn-Werkstätten Linz.) R. Dub and E. Suchy. With plan of the shops and details of the generating station, cranes and machinery. 3000 w. Elektrotech Zeitschr—Feb. 4, 1904. No. 60961 B.

Machine Tools.

Machine Tools. Gives extracts from a paper by James K. Cullen, presented to the Western Ry. Club, with editorial notes. 3000 w. Loc Engng—Feb., 1904. No. 60582 C.

Moulding.

Making Complicated Pieces in Moulding Machines (Herstellung Komplizierter Gegenstande auf Formmaschinen). F. Wüst. Giving examples of moulding flanged pulleys, bevel gears, etc., by machinery. 1200 w. Stahl u Eisen—Feb. 1, 1904. No. 60985 D.

Piano Factory.

A Modern Piano-Forte Factory. Illustrates and describes the plant of John Broadwood and Sons, Limited, at Old Ford. 1200 w. Engr, Lond—Feb. 12, 1904. No. 61004 A.

The Electrical Plant at the Broadwood Grand Piano-Forte Factory at Old Ford. Illustrated detailed description. 2800 w. Elec Engr, Lond—Feb. 5, 1904. No. 60812 A.

Portable Machines.

Portable Electric Drilling and Riveting Machines. Frank C. Perkins. Illustrations of various types with descriptions. 1600 w. Cassier's Mag—Feb., 1904. No. 61068 B.

Riveted Joints.

Efficiencies of Riveted Joints. Gilbert S. Walker. Gives a diagram for determining the efficiency, explaining the method of using it. 2000 w. Eng News—Feb. 4, 1904. No. 60679.

Shafting Lathe.

Shaft Turning Machine. H. Robinson. An illustrated description of a new semi-automatic double-head turning machine. 600 w. Am Mach—Jan. 28, 1904. No. 60547.

Shop Equipment.

Factory Schemes—Overhead Trolley Systems and Dipping Apparatus. S. A. Worcester. Outline drawings and description of these appliances and their operation. 1200 w. Am Mach—Feb. 11, 1904. No. 60774.

Shops.

Shop No. 3 of the Bullock Electric Mfg. Company. Illustrated detailed description. 1800 w. Mach, N Y—Feb., 1904. No. 60559 C.

The New Henry R. Worthington Hydraulic Works at Harrison, N. J. The present article gives an illustrated description of foundations, power plant, transportation and machine erecting shops. 5000 w. Eng Rec—Feb. 6, 1904. Serial. 1st part. No. 60662.

Shop System.

Two Card Systems for the Shop. H. C. Hammack. Explains a card index method of keeping employees' records, and outlines a "follow up" system for manufacturers and jobbers. 2500 w. Ir Trd Rev—Feb. 4, 1904. No. 60657.

Shrink Fits.

Removing Shrink Fits—Freeing a Set Idler. D. S. Cole. Illustrations with description of methods used by the writer. 2500 w. Am Mach—Feb. 4, 1904. No. 60635.

Special Tools.

Special Machine Tools at the Corliss Shops. Illustrates and describes designs of two decades ago made by Mr. Corliss for economical production of his engines. 4300 w. Ir Age—Feb. 4, 1904. No. 60601.

Tube Making.

The Manufacture of Charcoal Iron Railway Boiler Tubes. George G. Crawford. An illustrated description of the various processes from the charcoal pig iron to the finished tube. Discussion. 2500 w. Pro W Ry Club—Jan. 19, 1904. No. 60803 C.

The Manufacture of Welded Pipe. Victor Beutner. Reviews the history of tube manufacture, the material used, the design of pipe mills, the pipe welding furnace, and the bending furnace in the present number. Ill. 4300 w. Ir Age—Feb. 4, 1904. Serial. 1st part. No. 60602.

Wheels.

The Manufacture of Chilled Iron Wheels. Illustrated description of the work as carried out at the Edinburgh works of Messrs. Miller & Co. 2000 w. Tram & Ry Wld—Feb. 11, 1904. No. 61075 B.

Wire Netting.

Making Wire Netting. An illustrated description of interesting wire-working devices embodied in a machine invented by Charles W. James. 1000 w. Am Mach—Feb. 4, 1904. No. 60637.

Wood-Working.

Modern Wood-working Machinery. M. Powis Bale. A résumé of the chief and latest types in use, illustrated from recent photographs, with remarks on design, speeds, etc. 4300 w. Engng Rev—Feb., 1904. Serial. 1st part. No. 61066 B.

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MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of High Tensile Strength. Herbert E. Field. A reply to a correspondent who has had trouble in securing a strong composition by using Dr. R. H. Thurston's formula. 1800 w. Mach, N Y—Feb., 1904. No. 60561 C.

Preparing Alloys for Casting. Walter J. May. Some points on the making and handling of alloys. 1200 w. Prac Engr—Jan. 29, 1904. No. 60702 A.

The Segregatory and Migratory Habit of Solids in Alloys and in Steel Below the Critical Points. J. E. Stead, in *Jour. of the Soc. of Chem. Ind.* An illustrated study with conclusions reached. 6300 w. Ir & Steel Met—Feb., 1904. No. 60735 D.

Cast Iron.

Recent Investigations and Discoveries in Cast Iron. Alexander E. Outerbridge, Jr. Calls attention to hitherto unobserved properties as determined by experiments. Tabulated results, and discussion. Ill. 6800 w. Jour Fr Inst—Feb., 1904. No. 60729 D.

The Testing of Cast Iron. Dr. R. Moldenke. Read before the New England Found. Assn. Gives proposed specifications upon which cast iron may be bought and sold, discussing related matters. 3500 w. Ir Age—Feb. 18, 1904. No. 60861.

The Resistance and Structure of Cast Iron (Festigkeit und Struktur des Gusseisens). Oskar Leyde. Giving data and results of trials on test bars, showing the influence of dimensions on structure. 2500 w. 1 plate. Stahl u Eisen—Jan. 15, 1904. No. 60982 D.

Convention.

The Fifth Convention of the German Society for Testing Materials (Die Fünfte Hauptversammlung des Deutschen Verbandes für die Materialprüfungen der Technik). A general report of the proceedings of the meeting of Sept. 5, 1903, at Rübeland (Harz). 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1904. No. 60923 D.

Elastic Limit.

The Elastic Limit of Metals. Discusses the Investigations of M. Frémont. Ills. 1700 w. Nature—Jan. 21, 1904. No. 60569 A.

Microstructure.

On the Microstructure of Metals and Alloys. William Campbell. An interesting illustrated paper showing the value of microscopic study of metals and treatment that causes changes. 3800 w. Elec-Chem Ind—Feb., 1904. No. 60650 C.

Nickel Steel.

The Determination of Nickel in Steel. (Dosamento del Nichelio nell' Acciaio). Luigi Zambelli. Describing a laboratory method for the quantitative determination of the percentage of nickel in a nickel-steel alloy. 1800 w. Rivista Marittima—Jan., 1904. No. 60950 H.

Paints.

The Technology of Paint and Varnish. Alvah Horton Sabin. Gives a review of the use of paints and varnishes, giving much information in regard to them. 4500 w. Cassier's Mag—Feb., 1904. No. 61069 B.

Steel Castings.

Steel Castings. C. W. Gennet, Jr. Aims to correct false impressions and to give information concerning the material and its adaptations. 2500 w. R R Gaz—Feb. 26, 1904. No. 61086.

The Widening Use of Steel Castings in the United States. W. P. Barba. Reviews some of the newer uses of steel castings. Ills. 4000 w. Cassier's Mag—Feb., 1904. No. 61070 B.

Sulphuric Acid.

On the Manufacture of Sulphuric Acid at Sydney, C. B. Presented at meeting of the Canadian Min. Inst. Gives a sketch of the process, discussing details as carried out at the Dominion & Steel Co.'s plant in Sydney, Nova Scotia. 4200 w. Can Min Rev—Jan. 31, 1904. No. 60656 B.

Testing.

See Mechanical Engineering, Measurement.

Thermit.

Thermit: Its Application to Metallurgical Engineering. C. V. Boys. Calls attention to some peculiar properties of aluminium, shared also to some extent by magnesium, and gives the history and development of thermit. General discussion. 8800 w. Jour Soc of Arts—Feb. 12, 1904. No. 60874 A.

MEASUREMENT.

Graphostatics.

Graphostatic Computations for Moving Machine Parts (Grundzüge einer Graphostatischen Berechnung Bewegter Maschinenteile). Paul Wostrowsky. With diagrams analysing the inertia forces of moving bodies; with practical applications. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 15, 22, 1904. No. 60924 each D.

Kinemometer.

A Differential Recording Kinemometer (Sur un Cinémometre Différentiel Enregistreur). J. Richard. Illustrating and describing a recording apparatus capable of showing speed variations to the thousandth part of a second. 1200 w. Comptes Rendus—Jan. 18, 1904. No. 60932 D.

Meter.

A Steam Meter. R. S. Bayntun. Illus-

trates and describes an invention for measuring and recording the weight of quantity of steam passing through a pipe. 1400 w. Elec Rev, Lond—Feb. 5, 1904. No. 60814 A.

Pyrometers.

Recent Progress in High Temperature Measurement (Die Neuesten Fortschritte in der Messung Hoher Temperaturen). Dr. Ludwig Harald Schütz. A fully illustrated account of the most recent forms of pyrometers, including metallic, electric and optical varieties. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1904. No. 60921 D.

The Wanner Pyrometer. Illustrates and describes this apparatus for measuring high temperatures. 1500 w. Ir Age—Feb. 18, 1904. No. 60862.

Stresses.

Alternate Bending Stresses. Charles B. Dudley. Some remarks on the strains involved and the kind of metal best calculated to resist them. Ills. 1700 w. Ir & Steel Met—Feb., 1904. No. 60734 D.

Testing.

Testing of Iron and Steel. A. N. Kemp. Considers the usual methods of testing, describing two of the best known machines. Ills. 4000 w. Engng Times—Feb., 1904. No. 61059 B.

Testing Machine.

A Large Testing Machine. An account of the recently completed machine for the testing laboratory of Paris, adapted for testing all kinds of substances. 1200 w. Engr, Lond—Jan. 29, 1904. No. 60720 A.

The Emery Testing Apparatus at the Massachusetts Institute of Technology. Day Allen Willey. Illustrated description of experimental apparatus for testing material used in the construction of bridges, buildings, vessels, etc. 1400 w. Sci Am Sup—Jan. 30, 1904. No. 60574.

POWER AND TRANSMISSION.

Central Station.

A Central Heating, Lighting and Ice-Making Station, Gulfport, Miss. An illustrated description of a station for supplying heat, light and ice to an adjacent hotel and other buildings. 1300 w. Eng Rec—Feb. 27. 1904. No. 61089.

Compressed Air.

Air Compressors (Luftkompressoren). E. W. Koester. A review of the performance of various arrangements of steam and air cylinders with diagrams showing the distribution of work, and the flow in the passages. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1904. No. 60916 D.

A New Vacuum System for Pneumatic Transmission. Illustrates and describes the system based on the Dinspel-Stoetzel patents. 2500 w. Ir Age—Feb. 11, 1904. No. 60693.

Compound Multiple-Stage Air Compressor (Verbund - Stufenkkompressor). Julius Divis. Describing an improved Riedler compressor of 70 cubic metres per minute capacity, recently erected at Nurschau, Bohemia. 1500 w. 1 plate. Glückauf—Jan. 23, 1904. No. 60944 D.

Explosion in Compressed Air Pipes at Aberbeeg Colliery, Monmouthshire. R. Jordan. Read before the So. Wales Inst. of Engrs. An account of an explosion occurring April 9, 1902, with discussion of cause. 2700 w. Col Guard—Jan. 22, 1904. No. 60614 A.

Pneumatic Tools and Compressed Air for General Railroad Work. W. P. Pressinger. Considers some of the latest devices, particularly appliances not in general use. General discussion. 11200 w. Ry Club of Pittsburgh—Dec., 1903. No. 60758 C.

The Operation of Compressed Air Motors with Expansion (Betrieb von Druckluftmotoren mit Expansion). H. Althans. An examination of the practicable increase in efficiency of compressed-air motors for mining service. 1500 w. Glückauf—Jan. 30, 1904. No. 60946 D.

Sawing by Compressed Air. Illustrated detailed description of a pneumatic saw, known as the Redfield pneumatic engine and frame. 800 w. Compressed Air—Feb., 1904. No. 60869.

Cone-Pulleys.

A Graphic Solution of the Open-Belt Cone-Pulley Problem. Lucien E. Picolet. Presents graphical solution. 1000 w. Am. Mach—Feb. 18, 1904. No. 60854.

Conveying.

A Novel Coal Handling Plant. Illustrates and describes the hoisting plant for the Milwaukee Electric Railway and Light Company. The coal is stored at the top of the building and a special method was devised to handle it rapidly and economically. 500 w. Eng News—Feb. 25, 1904. No. 61082.

Elevators.

Electrically-Driven Hydraulic Passenger Lifts. An illustrated description of the passenger elevators installed at the Shepherd's Bush Station of the Central London railway. 1800 w. Engng—Feb. 5, 1904. No. 60827 A.

Some Notes on a Recent Elevator Accident. Charles R. Pratt. An explanation of the Frazier system which operated the elevators at 74 Broadway, New York, where an accident occurred Feb. 2, 1904. Also refers to other systems. 1600 w. Eng News—Feb. 11, 1904. No. 60789.

Exposition.

Some Details of the Louisiana Purchase Exposition Service Power Plant. Illus-

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trates some of the more interesting details of this plant, discussing the novel features. 4000 w. Eng Rec—Feb. 27, 1904. No. 61091.

Hoist.

A Special Lift. S. A. Worcester. Illustrated description of a lift designed to be used in connection with the binder of a harvesting machine, explaining the operation. 900 w. Am. Mach—Feb. 4, 1904. No. 60634.

Shafting.

Construction of Line Shafting. H. E. Raabe. Suggestions for improving the form of shafts, showing the weakness of several designs. 1200 w. Marine Engng—Feb., 1904. No. 60647 C.

Spiral Gears.

Graphical Solutions for Spiral Gears. A. Thompson. An explanation of the graphical method used by the writer. 1000 w. Am Mach—Jan. 28, 1904. No. 60549.

Variable Speed.

An Improved Electro-Mechanical Variable-Speed Gear (Nouveaux Dispositifs Electromécaniques d'Embrayage et de Changement de Vitesse Progressifs). Paul Gasnier. A combination of an epicyclic gear train, a motor and a dynamo, the latter in connection with a rheostat, regulating the driving reaction. 1500 w. Comptes Rendus—Dec. 28, 1903. No. 60931 D.

INTERNAL-COMBUSTION MOTORS.

Carburetters.

Carburators, Vaporizers and Volatilizers Used in Petrol, Alcohol, Kerosene and Crude Oil Engines. E. Butler. Illustrates and describes various types of carburators in the present article. 2400 w. Engng Rev—Feb., 1904. Serial. 1st part. No. 61064 B.

Furnace Gas.

Blast Furnace Gas as the Sole Motive Power of a Modern Iron Works (Hochofengas als Alleinige Betriebskraftquelle eines Modernen Hüttenwerks). Karl Gruber. Showing the amount of power available in waste furnace gases, and the practicability of its use. Two articles, 7000 w. Stahl u Eisen—Jan. 1, 15, 1904. No. 60976 each D.

Gas Engines.

Engines for Use with Lean Gas (Les Moteurs à Gaz Pauvre). A. Abraham. An exhaustive examination of the thermal and mechanical conditions involved in the direct production of power from gases of low calorific value. Serial. Part I. Revue Technique—Jan. 10, 1904. No. 60910 D.

Gas Engines in Railway Work. William T. Magruder. Reviews the different classes of engines now on the market, aiming to give a general view of the entire field, and considers the purposes for which they are used in railway work, giving some results, and discussing other uses to which they may be applied. 10800 w. Pro Cent Ry Club—Jan. 8, 1904. No. 60830 C.

Gasoline Motors.

Design for a Two-Cycle Gasoline Motor. J. C. Brocksmith. Gives working drawings of a two-cylinder two-stroke-cycle air-cooled type of gasoline motor adapted to light automobile work, with descriptive notes. 2500 w. Am Elect'n—Feb., 1904. No. 60598.

Governing.

Governing Gas and Gasoline Engines. Dugald Clerk. Read before the Auto Club of Great Britain & Ireland. A review of methods used in the past and present. 3300 w. Mech Engr—Feb. 6, 1904. No. 60805 A.

Petrol Engine.

The Crossley Petrol Engine. An illustrated article describing details of construction. 2000 w. Auto Jour—Feb. 13, 1904. No. 60879 A.

STEAM ENGINEERING.

Boilers.

Boiler Material and Boiler Corrosion (Kesselmaterial und Kesselcorrosionen). H. Rinne. A discussion of the influence of boiler material upon the nature and extent of corrosion. 4000 w. Stahl u Eisen Jan. 15, 1904. No. 60981 D.

Boiler Room Practice. W. T. Edwards. A discussion of various practices and things necessary to the safe management of boilers. 2500 w. Am Elect'n—Feb., 1904. No. 60600.

Blowing Engine.

The Mackinac Blowing Engine at the Calumet and Hecla Mines. Joseph S. Soddy. Illustrates and describes a four-cylinder, triple-expansion condensing engine, rated at 7000 h. p. capacity, and to be the largest of this type in the world. 1000 w. Power—Feb., 1904. No. 60576 C.

Coal Consumption.

Coal Consumption in Central Stations. Alfred S. Giles. Slightly condensed paper read before the Manchester Soc. of the Inst. of Elec. Engrs. A study of the question of fuel economy. 3500 w. Mech Engr—Jan. 23, 1904. No. 60609 A.

Corliss Valves.

The Corliss Valve for Marine Work. Charles M. Jones. Shows the ease with which the valve may be fitted, and claims it is as near perfect against leakage as can be wished. 800 w. Am Shipbldr—Feb. 11, 1904. No. 60723.

Explosion.

A Peculiar Explosion of Water-tube

Boilers. John E. Higdon. An illustrated account of the wreck of the boiler house and boilers of the St. Louis Transit Company. 1300 w. Eng. Rec.—Feb. 13, 1904. No. 60782.

A Remarkable Boiler Explosion. An illustrated account of the explosion which occurred Dec. 21 at the Geyer Avenue Power Station of the St. Louis Transit Company. 2700 w. Power—Feb., 1904. No. 60577 C.

Feed Water.

New Type of Purifying Plant—Industrial Water Company. Illustrated description of plant built for the Houston Coal and Coke Company at Elkhorn, W. Va. 1000 w. R. R. Gaz—Feb. 12, 1904. No. 60795.

The Water Softening Plant of the Procter & Gamble Co., Ivorydale, O. Illustrates and describes a new plant having a capacity of 35,000 gallons per hour. 900 w. Eng. News—Jan. 28, 1904. No. 60565.

Firing.

Mechanical Auxiliaries to the Economy of the Fireroom. Reginald Pelham Bolton. Including coal and ash conveyors, mechanical stokers, and the detailed appliances of the modern boiler house. 4000 w. Engineering Magazine—March, 1904. No. 60992 B.

Governors.

The Development of the Shaft Governor. William O. Webber. An illustrated article briefly considering three classes of shaft governors. 1400 w. Engr, U S A—Feb. 1, 1904. No. 60563 C.

Mechanical Draft.

Mechanical Draft. J. I. Lyle. Read before the Engine Builders' Assn. Explains the advantages of forced draft, describing types. 2000 w. Engr, U S A—Feb. 15, 1904. No. 60868.

Pistons.

Pistons and Packing Rings. Amos Price. Reports ideas advanced at a recent meeting of an engineers' society when this subject was discussed. Ills. 1700 w. Am Mach—Feb. 4, 1904. No. 60636.

Prime Movers.

The Prime Mover and Its Influence on the World's Progress. John E. Sweet. Reviewing the development of the steam engine, and the effects upon civilization and material progress; with numerous illustrations. 4000 w. Engineering Magazine—March, 1904. No. 60988 B.

Steam Engines.

Portable Engine and Saw Bench. Illustrates and describes an engine and self-acting saw bench for pioneer work in forests, light enough to be easily transported. 500 w. Engr, Lond—Feb. 12, 1904. No. 61005 A.

Steam and Internal Combustion Engines Compared for Central Station Work. Norman McCarty. Gives a statement showing the itemized cost of operation of light internal combustion engine plants, of the Diesel type, comparing with the cost of operation when steam engines are used. 1800 w. Elec Rev, N Y—Jan. 30, 1904. No. 60525.

Theory of a New Method of Converting the Energy in Steam into Mechanical Work (Theoretische Betrachtung über eine Neue Art der Umsetzung von Dampfenergie in Mech. Arbeit). Eugen Dolder. A discussion of the theoretical possibility of utilizing the kinetic energy of a discharge of steam to a higher degree than heretofore. With comments by Prof. Stodola. 1200 w. Schweiz Bauzeitung—Jan. 16, 1904. No. 60928 B.

Verticle Triple-Expansion Engine (Stehende Dreifachsexpansions - Dampfmaschine). S. Iglauer. Brief illustrated account of 1000 h. p. engine forming part of generating set in the generating station at Budapest, Hungary. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 16, 1904. No. 60914 D.

Steam Flow.

Researches Upon the Discharge of Steam (Versuche über den Ausfluss des Wasserdampfes). M. F. Gutermuth. With tables and curves giving the discharges from various kinds of orifices based on recent experiments made at the technical high school at Darmstadt. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 16, 1904. No. 60915 D.

Steam Jacket.

The Economical Use of the Steam Jacket. A. H. Gibson. Considers under what conditions a steam jacket may or may not conduce to economy. 3000 w. Engng Rev—Feb., 1904. No. 61063 B.

Steam Turbines.

Efficiency Test of 1250 K. W. Steam Turbine for Interborough Company, New York City. A. M. Mattice. Gives important results of a series of performance tests upon a 1250 k. w. Westinghouse-Parsons steam turbine generating unit. Ill. 2500 w. Elec Wld & Engr—Feb. 20, 1904. No. 61027.

Notes on the Curtis Turbine. Reviews a portion of a paper by F. Samuelson, read before the Rugby Engng. Soc. Ill. 800 w. Elect'n, Lond—Feb. 5, 1904. No. 60817 A.

Notes on the Brown-Boveri-Parsons Steam Turbine (Mitteilungen über Dampfturbinen von Brown-Boveri-Parsons). O. Reidt. Data and results of tests upon Swiss-built Parsons turbines in various parts of Germany. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1904. No. 60917 D.

The Curtis Steam-Turbine. An illustrated description of this type and an ex-

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planation of its working. 2000 w. Engng—Feb. 5, 1904. No. 60826 A.

The Riedler-Stumpf Steam Turbine. Abstract of a paper by Dr. A. Riedler, published by the *Schiffbautechnische Gesellschaft*. An illustrated account of an important German wheel in successful use. 3000 w. Mach, N. Y.—Feb., 1904. No. 60560 C.

The Riedler-Stumpf Steam Turbines. Illustrated description of the special features, with remarks. 3000 w. Engng—Feb. 12, 1904. No. 60892 A.

The Steam Turbine. William Chilton. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. An illustrated description of the principal types and their operation. 3300 w. Prac Engr—Feb. 12, 1904. Serial. 1st part. No. 60898 A.

The Turbine Problem. H. F. Schmidt. Considers the principles and theories underlying the construction of vapor turbines. 5000 w. Am Elect'n—Feb., 1904. No. 60597.

See Also Electrical Engineering, Generating Stations.

Superheating.

Superheated Steam. Discussion of paper by F. J. Rowan. 5000 w. Ills. Trans Inst of Engrs & Shipbldrs in Scotland—Vol. 47, Part III. No. 60730 D.

Thermal Diagrams.

Thermal Diagrams and Their Practical Use. Hugo Diemer. Gives methods for constructing thermal diagrams, which with information given by indicator cards and other data usually taken during an engine test, will disclose all heat interchanges and heat relationship. 2500 w. Bul Univ of Kansas. Vol. II., No. 6.—Nov., 1903. No. 60752 D.

Valve Gears.

Valve Gears. C. C. Major. Discusses the effect of connecting-rod angularity. 1000 w. Am Elect'n—Feb., 1904. No. 60599.

Valves.

Causes of Explosions of Cast-Iron Steam Valves (Causes d'Explosion des Valves en Fonte). S. Perissé. Discussing the importance of providing by-pass communication to avoid water-hammer shocks and consequent ruptures. 2000 w. Génie Civil—Feb. 6, 1904. No. 60906 D.

MINING AND METALLURGY

COAL AND COKE.

Calorimeters.

Comparison of Different Types of Calorimeters Extract from a paper by J. S. S. Brame and Wallace A. Cowan read before the London Sec. of the Soc. of Chem. Ind., giving a report of investigations and the results. 1700 w. Gas Wld—Jan. 23, 1904. No. 60610 A.

Coke.

The Valuation of Furnace and Foundry Coke (Die Bewertung von Hochofen und Giessereikoks). Oskar Simmersbach. A discussion of the various properties of coke which should be considered in estimating its value. 3500 w. Stahl u Eisen—Feb. 1, 1904. No. 60983 D.

Coke-Drawing.

The Hebb Coke-Drawing Machine. Illustrates and describes a device recently built for mechanically removing the coke from the coke ovens. 1300 w. Mines & Min—Feb., 1904. No. 60625 C.

Colorado.

The Walsenburg Coal District of Colorado, R. C. Hills. Abstract of monograph published by the U. S. Geol. Survey. A description of the geology, the area and the different coal seams found. Ills. 2500 w. Mines & Min.—Feb., 1904. No. 60632 C.

Dusty Mines.

The Spraying or Watering Problems of Dusty Mines. James Ashworth. Dangers connected with spraying as shown by various experiments and dust explosions. 1800 w. Mines & Min—Feb., 1904. No. 60626 C.

France.

In the French Black Country. Remarks on St. Etienne, the conditions of mining, hours of labor, wages, &c. 2800 w. Ir. & Coal Trds Rev—Jan. 29, 1904. No. 60824 A.

Mining Devices.

Mechanical Devices at Coal Mines. L. L. Logan. Read before the Cent. Min. Inst. of W. Penn. Illustrates some improvements in car-dumps, mine-car running gear, and rock-dumping apparatus. 3500 w. Mines & Min—Feb., 1904. No. 60631 C.

New Zealand.

Coal Mining in New Zealand. Information from the annual report of the Minister of Mines for New Zealand, for year ending Dec. 31, 1902. 1400 w. Col Guard—Feb. 12, 1904. No. 60891 A.

Norton Coals.

The Norton Coals of the Big Sandy Basin. H. W. Althouse. An illustrated description of deposits in Virginia and Kentucky. 1400 w. Eng & Min. Jour—Feb. 11, 1904. No. 60783.

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San Pedro.

Geology of the San Pedro District, San Luis Potosi, Mexico. George Irving Finlay. An account of the geological relations of the ore bodies, intended to supplement the paper of George F. Laird in which the conditions of the San Pedro mines were outlined and the development described. Ill. 3200 w. Sch of Mines Qr—Nov., 1903. No. 60834 D.

Slate-Pickers.

Mechanical Slate-Pickers. Considers appliances used in the dry method of separating the slate from anthracite coal. Ill. 2500 w. Eng & Ming Jour—Feb. 25, 1904. No. 61094.

Structure.

On the Structure of Coalfields. Thomas Parton. Read before the N. S. W. Chamber of Mines. Details on the structure of coalfields with special reference to the splitting of seams. 5000 w. N Z Mines Rec—Dec. 16, 1903. No. 60699 B.

Surveying.

Anthracite Mine Surveying Practice. Brief account summarizing the methods of several companies. 1600 w. Eng & Min Jour—Feb. 11, 1904. No. 60785.

Washington Mines.

Coal Production of Washington for 1903. C. F. Owen. Statement condensed from annual report of output. 900 w. Min. Rept—Feb. 11, 1904. No. 60856.

West Virginia.

The Henry Colliery. J. T. Jennings. Description of extensive modern developments in the coal mines of West Virginia. 3500 w. Eng & Min Jour—Feb. 18, 1904. No. 61045.

COPPER.

Consolidation.

The British Columbia-Snowshoe Consolidation. E. Jacobs. An account of the uniting of two low-grade copper mines to the mutual interest, with description of the properties. Ill. 2000 w. Eng & Min Jour—Jan. 28, 1904. No. 60558.

Ores.

Copper Ores and Their Physical Appearance. Describes the principal copper minerals with which a prospector has to deal. 1300 w. Min & Sci Pr—Jan. 23, 1904. No. 60541.

Supplies.

Copper Supplies. Editorial review of the supplies of copper to Europe during last year, and discussion of the probable production throughout the world. 2000 w. Engng—Jan. 22, 1904. No. 60618 A.

GOLD AND SILVER.

Alaska.

The Mining Prospects on Seward Peninsula. A report by the United States geologist on the placer mines in this part of Alaska. 700 w. Pacific C Min—Feb. 13, 1904. No. 60872.

British Columbia.

Quesnelle Forks Mining Division of British Columbia. W. M. Brewer. Illustrated description of a great placer mining region and the developments. 4000 w. Mines & Min—Feb., 1904. No. 60623 C.

Colorado.

Mining Problems in Colorado. Percy A. Leonard. Remarks on recent improvements in smelting and cyanide practice, and other advances in development. 1000 w. Min & Sci Pr—Jan. 30, 1904. No. 60670.

Cyanide.

A Colorimetric Method for the Determination of the Gold in Cyanide Solutions. Prof. A. Prister. Explains the chemistry and practical working of the method. 1500 w. Jour of Chem, Met & Min Soc of So. Africa—Dec., 1903. No. 61011 E.

Improvements in Cyanidation. Alfred James. Reproduction of the larger portion of a circular letter in cyanide practice. 1800 w. Eng & Min Jour—Jan. 28, 1904. No. 60557.

Notes on the Limitations of the Cyanide Process. H. T. Durant. Deals principally with ores in which gold is carried free in quartz or other gangue. 1200 w. Jour of Chem., Met & Min Soc of So Africa—Dec., 1903. No. 61010 E.

The Electric Reduction of Gold from Cyanide Solutions. A. A. Beadle. Explains the advantage of electrical reduction in the treatment of refractory ores. 1000 w. Min & Sci Pr—Jan. 30, 1904. No. 60672.

Homestake.

Discovery and Development of the Homestake Mine. Brief account of this large low-grade gold mine. 1300 w. Min & Sci Pr—Jan. 23, 1904. No. 60542.

Some Features of Mining Operations in the Homestake Mine, Lead, South Dakota. Illustrations, with description, of features of one of the largest and most productive gold mines in the world. 2000 w. Min & Sci Pr—Feb. 13, 1904. Serial. 1st part. No. 61030.

Kolar Gold-Field.

The Geology of the Kolar Gold-Field. A. Mervyn Smith. Abstract of a paper read before the Inst. of Min. & Met., London. An illustrated description. 1500 w. Eng & Min Jour—Feb. 11, 1904. No. 60784.

New Mexico.

Notes on New Goldfields, Sierra County, New Mexico. E. P. Smith. Describes a discovery on the east side of the Rio Grande, and the crude methods of treat-

ing. 800 w. Min & Sci Pr—Jan. 23, 1904. No. 60540.

New Zealand.

Notes on the Geology, Quartz Reefs and Minerals of the Waihi Goldfield. P. G. Morgan. An account of the mining geology of this field, with list and description of minerals found. 7000 w. N Z Mines Rec—Dec. 16, 1903. No. 60697 B.

The Romance of Gold-Mining. A. W. Tyndall. Prize Essay. An account of the discovery of the Blue Spur, near Lawrence, Otago. 1800 w. N Z Mines Rec—Dec. 16, 1903. Serial. 1st part. No. 60-698 B.

Slimes.

A Trapezoidal Slimes Agitator. Courtenay De Kalb. An illustrated description of a device used in California, with report of results. 1300 w. Eng & Min Jour—Feb. 11, 1904. No. 60786.

Smelting.

Notes on Smelting and Cupellation. F. L. Piddington. Describes the method generally used in the treatment of small parcels of rich material. 1500 w. Jour of Chem, Met & Min Soc of So Africa—Dec., 1903. No. 61009 E.

West Australia.

Recent Progress in West Australia. J. H. Curle. Concerning the gold fields of this region. 1600 w. Eng & Min Jour—Feb. 18, 1904. No. 61044.

Yukon.

The New Mayo Mining District. L. Netland. Illustrated article giving an account of the rich prospects revealed by the government survey of this new section of the Yukon territory, Canada. 3800 w. Pacific C Min—Jan. 30, 1904. No. 60621.

See also Electrical Engineering, Electrochemistry.

IRON AND STEEL.

Brittleness.

The Brittleness of Steel. H. le Chatelier. Remarks on the intermittent brittleness of steel, the causes, &c., discussing the nature of the metal, external conditions, and tests. 4000 w. Ir & Steel Met—Feb., 1904. No. 60733 D.

Cast Iron.

See Mechanical Engineering, Materials.

Converters.

Sideblown Steel Converters. N. Lilienberg. Extract from a paper read before the Philadelphia Foundrymen's Association. Discusses the advisability of erecting such a plant from the manufacturer's point of view, the advantages and disadvantages. 5000 w. Foundry—Feb., 1904. No. 60531.

Ferronickel.

Ferronickel Direct from Pyrrhotite. Ernst A. Sjötedt. Reviews the manner of manufacturing ferronickel direct from the Sudbury nickliferous pyrrhotite, illustrating the roasting furnace invented by the writer. 2500 w. Ir Age—Feb. 18, 1904. No. 60860.

Furnaces.

Coal-Fired Reverbatory Furnaces for Heating Iron and Steel. R. T. Cooke. Explains the principles of these furnaces and the methods of working and repairing. Ill. 1600 w. Prac Engr—Jan. 22, 1904. No. 60608 A.

Gas Furnaces.

Proportions of Regenerative Gas Furnaces, with Special Reference to Open-Hearth Furnaces. H. D. Hess. An illustrated article presenting the advantages of these furnaces, and discussing their management and construction. Short discussion. 5000 w. Pro Engrs' Club of Phila—Jan., 1904. No. 60762 D.

Heat Treatment.

The Semi-Solid State in Metals. Thos. Turner. Read before the Staffordshire Iron & Steel Inst. With special reference to the strength of cast-iron and the heat treatment of steel. 5400 w. Ir & St Trds Jour—Jan. 30, 1904. No. 60554 A.

Minnequa Works.

The Minnequa Works of the Colorado Fuel & Iron Company. Illustrated description of these large iron and steel works located at Pueblo, Colorado. 6000 w. Ir & Coal Trds Rev—Jan. 29, 1904. No. 60823 A.

Pig Iron.

Gases in Pig Iron (Ueber Gase im Roheisen). E. Nümkes. Describing the method of determining gases contained in melted pig iron; with results of analyses. 2500 w. Stahl u Eisen—Jan. 1, 1904. No. 60979 D.

Report.

Report of a Visit to the United States (Bericht über eine Studienreise nach den Ver. Staaten von Nordamerika). H. Macco. An account of a visit to the Minnesota ore deposits and the iron and steel furnaces of Western Pennsylvania; being a report to the Verein Deutscher Eisenhüttenleute. Two articles. 12000 w. Stahl u Eisen. Jan. 15, Feb. 1, 1904. No. 60-980 each D.

Rolling Mill.

Universal Rolling Mill of the Burbach Works (Universalwalzwerksanlage der Burbacher Hütte). Illustrating and describing an installation with direct-connected steam engine and hydraulically operated tables. 1200 w. 1 plate. Stahl u Eisen—Jan. 1, 1904. No. 60975 D.

Rolls.

Notes on the Design of Rolls. Emil

Kirchberg. From a paper printed in *Stahl und Eisen*, with additions. Notes on recent changes, influence of temperature, draft, reheating, &c. Ill. 4300 w. Ir & Coal Trds Rev—Jan. 22, 1904. No. 60633 A.

Separators.

Two New Magnetic Ore Separators (Zwei Neue Magnetische Erzscheider). Dr. Hecker. Describing the Forsgren and the Eriksson separators, used in the magnetite districts of Norway and Sweden. 1800 w. Glückauf—Jan. 23, 1904. No. 60943 D.

Slag.

The Constitution of Ferromanganese Slags (Ueber die Zusammensetzung der Schlacken bei der Ferromanganerzeugung). F. Wittman. Giving a table of analyses of various slags, and a curve showing the relative percentages. 1000 w. Stahl u Eisen—Jan. 1, 1904. No. 60977 D.

Steel Castings.

See Mechanical Engineering, Materials.

MINING.

Ankylostomiasis.

Ankylostomiasis. Report of a recent debate in the German Reichstag. 3800 w. Col Guard—Jan. 29, 1904. Serial. 1st part. No. 60710 A.

Discussion upon the Hook Worm Disease (Verhandlungen über die Wurmkrankheit). A report of the discussion in the Reichstag upon the hook worm disease in the German mines, from the official stenographic notes. Special supplement. 50000 w. Glückauf—Jan. 23, 1904. No. 60945 D.

British Columbia.

Mining in British Columbia in 1903. Briefly reviews the progress made in each district, showing the development. 5000 w. Eng & Min Jour—Feb. 25, 1904. No. 61095.

The British Columbia Mining Industry in 1903. H. Mortimer Lamb. A review of the conditions influencing it during the past year. 6000 w. Mines & Min—Feb., 1904. No. 60629 C.

Detonators.

Testing Caps or Detonators in the Laboratory. A. W. Warwick. Describes a method by which a record of the strength and quality is automatically made. 2500 w. Mines & Min—Feb., 1904. No. 60624 C.

Drill.

The "Drillibite" Hand Rock-Drill. Illustrated detailed description of a portable drill-holder and turner aiming to enable one man to do the work of two when drilling holes by hand-power. 1500 w. Engng—Jan. 29, 1904. No. 60717 A.

Electricity.

Report of the Electricity in Mines Committee. Gives the report of the Committee presented to the Home Secretary, under date January 19, 1904, with copy of rules for the installation and use of electricity in mines. Also editorial. 18700 w. Col Guard—Feb. 5, 1904. No. 60821 A.

The Dangers of Electricity in Mining (Die Gefahren der Elektrizität im Bergwerksbetriebe). A review of the applications of electricity in mining, with especial reference to the possible ignition of fire damp. Serial, Part I. 1800 w. Glückauf—Jan. 30, 1904. No. 60947 D.

Explosion.

Gas Explosion at Boryslaw (Schlagwetterexplosion in Boryslaw). Johann Holobek. An account of the disastrous explosion of fire-damp in the Boryslaw mines, Galicia, Austria, June 2, 1902. Two articles, 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 23, 30, 1904. No. 60942 each D.

Gravel Deposits.

Working Low-Lying Gravel Deposits by the Hydraulic Elevator System. R. H. Campbell. Illustrations of the latest improved Campbell hydraulic elevator, with remarks. 800 w. Min & Sci Pr—Feb. 13, 1904. No. 61031.

Haulage.

Electric Haulage in Metal Mines. W. N. Clark. Discusses the conditions of haulage in a metal mine, and describes the system used by the United Gold Mines Company of Victor, Colorado. 1700 w. Eng & Min Jour—Feb. 25, 1904. No. 61096.

Head Frames.

Simple Head Frame Construction. Shows a substantial frame constructed at the collar of a shaft, and explains the conditions. 1200 w. Min & Sci Pr—Feb. 6, 1904. No. 60866.

Hoisting.

The Pneumatic Hoist. M. Ehle, Jr. Discusses the value of the pneumatic system in hoisting from great depths. 1200 w. Min Rept—Feb. 11, 1904. No. 60855.

Kaffirs.

The Kaffir Mine-Workers. T. Lane Carter. Reports marked improvement in their efficiency, discussing the reasons, and outlining the methods of managing and caring for the miners. 1500 w. Eng & Min Jour—Feb. 18, 1904. No. 61047.

Mining Machinery.

The Development of Power-Driven Machinery in the Mine. E. H. Roberton. Discussing winding machinery, pumps, ventilating machinery, haulage systems, drills, coal cutters, etc. 3500 w. Engineering Magazine—March, 1904. No. 60994.

Ore Roasting.

Edwards' Mechanical Ore-Roasting Fur-

nace. F. Danvers Power. Illustrates and describes the three types of Edwards furnaces. 2500 w. Eng & Min Jour.—Feb. 11, 1904. No. 60787.

Pumping Plant.

Pumping Plant at the Miike Collieries, Japan. Illustrates and describes probably the largest pumping plant ever erected on one shaft. 900 w. Engng—Jan. 29, 1904. No. 60713 A.

Sampling.

Automatic Ore Sampling. Alfred Harvey. Line drawings and description of an automatic ore sampling plant, designed to take a correct sample with the least possible crushing of the ore. 1500 w. Min & Sci Pr—Jan. 30, 1904. No. 60671.

Utah.

Mines and Aerial Tramways of the U. S. Mining Co., at Bingham, Utah. W. P. Hardesty. An illustrated detailed description. 5000 w. Eng. News—Feb. 11, 1904. No. 60788.

Ventilation.

Mine Ventilation. W. J. Mollison. Read before the Cent. Min. Inst. of W. Penn. Importance of improvement in methods, and some of the points which need to be considered to attain it. 2300 w. Mines & Min—Feb., 1904. No. 60628 C.

Winding Engine.

Compound Winding Engine at Sherwood Colliery. Charles H. Heathcote. Illustrated detailed description. 1600 w. Ir & Coal Trds Rev—Jan. 29, 1904. No. 60822 A.

Electrical Winding Engines. Dr. R. Herzfeld. Refers to several systems and gives particulars of the "Koepe Wheel," and the advantages of electrical transmission of power. Ill. 3000 w. Engng—Feb. 12, 1904. No. 60893 A.

Tests of Steam Winding Engines (Untersuchungen an Dampffördermaschinen). Dr. H. Hoffmann. An investigation of the varying loads upon mine hoisting engines, and the corresponding effects upon the steam machinery, with numerous load and indicator diagrams. Two articles. 8000 w. Zeitschr d Ver Deutscher Ing—Jan. 30, Feb. 6, 1904. No. 60920 each D.

MISCELLANY.

Metallurgy.

Metallurgy as Applied in Engineering. Archibald P. Head. Address delivered to the students of the Inst. of Civ. Engrs., demonstrating the importance of the study of metallurgy. 8800 w. Engng—Feb. 12, 1904. No. 60897 A.

Oil Deposits.

New Texan Oil Deposits. Day Allen Willey. Information concerning the petroleum deposits of Texas and Louisiana. 1500 w. Ills. Sci Am—Jan. 30, 1904. No. 60572.

Platinum.

Platinum in British Columbia. R. W. Brock. An account of the conditions under which platinum is found to occur in British Columbia, found thus far in only small quantities. 1400 w. Eng & Min Jour—Feb. 18, 1904. No. 61046.

Quantitative Analysis.

Notes on Quantitative Analysis for Mining Engineers. Edmund H. Miller. Notes representing the methods as at present taught, and showing what is required of mining students at Columbia University. 14500 w. Sch of Mines Qr—Nov., 1903. No. 60833 D.

Quicksilver.

A New Quicksilver Field in Brewster County, Tex. William B. Phillips. Gives the location of this new field, with particulars concerning the district. 1500 w. Eng & Min Jour—Jan. 28, 1904. No. 60556.

Tin.

Determination of Tin in Tailings and Slimes. George L. Mackenzie. Read before the Inst. of Min. & Met. Gives details of the scheme of assay employed by the writer. 2000 w. Mine Rept—Feb. 4, 1904. No. 60687.

Zinc.

The Joplin Zinc District. Joe Plyn. Gives the location and history and describes the peculiarities of the ore bodies, the methods of operating, prospecting, mining, milling and selling the ores. 3800 w. Mines & Min—Feb., 1904. No. 60630 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

A Study of the Interstate Commerce Commission Accident and Safety-Appliance Reports. Extracts from the report of a committee of the Car Foremen's Ass'n of Chicago. 3000 w. R R Gaz—Feb. 5, 1904. No. 60683.

Technical Bureau.

A Central Technical Investigation Bureau for the Austrian Railways (Ein Technisches Zentral Studienbureau für das Eisenbahnwesen in Oesterreich). Dr. W. Exner. An examination of the project to establish a scientific bureau for the investigation of railway problems. 6000 w.

We supply copies of these articles. See page 157.

Zeitschr d Oesterr Ing u Arch Ver—Jan. 29, 1904. No. 60925 D.

Transportation.

Present Day Costs of Transportation by Rail and by Water. K. W. Blackwell. Presidential address before the Canadian Soc. of Civ Engrs. 2000 w. Eng News—Feb. 11, 1904. No. 60793.

Problems in Transportation by Rail in the United Kingdom. George Harrison Sheffield. Presidential address before the Newcastle-on-Tyne Assn. of Students of the Inst. of Civ. Engrs. Discusses needed improvements in rolling stock, electric power and other developments. 4200 w. R R Gaz—Feb. 12, 1904. No. 60797.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Retardation at Different Periods of the Stop. A discussion of the stop curve and the fact that the rate of retardation is much greater at the finish of the stop and less at the beginning. 700 w. Loc Engng—Feb., 1904. No. 60584 C.

The Pressure Retaining Valve: Its Value and Importance. F. H. Parke. An explanation of the results accomplished by this device, and an outline of the benefits when properly installed and maintained. 3800 w. R R Gaz—Jan. 29, 1904. No. 60566.

Axles.

Reports Upon an Investigation into the Stresses and Strains in Axles and Wheels in Service. F. B. Bissell. Shows the principal stresses and strains in axles and wheels, and how to so design that they may be taken safely. General discussion. Diagrams. 9000 w. Bro N Y R R Club—Jan. 15, 1904. No. 60831.

Cars.

A New 50-Ton Box Car. Illustrated description of a car with structural steel underframe, designed to meet special requirements in handling grain shipments. 1500 w. Am Engr & R R Jour—Feb., 1904. No. 60586 C.

Combination Dining, Parlor and Day Cars. Illustrated description of special cars designed for routes where the hauling of dining cars would not be justified. 800 w. Eng News—Feb. 18, 1904. No. 61039.

40-Ton Coal Car with Steel Underframe. Drawings, photographs and detailed description of some interesting cars recently constructed for a coal mining company. 800 w. R R Gaz—Feb. 5, 1904. No. 60682.

100,000 Lbs. Capacity Coal Cars—Chicago, Milwaukee & St. Paul Railway. Illustrated detailed description of the form of construction. 700 w. Ry Mas Mech—Feb., 1904. No. 60686.

Steel Cars on the Caledonian Railway of Scotland. Illustrations and descriptions of 30-ton cars recently put in service. 2200 w. R R Gaz—Feb. 19, 1904. No. 61034.

Steel Coke Car of Vanderbilt Design. Illustrated description of all-steel cars of large capacity. 450 w. Ry Age—Feb. 5, 1904. No. 60685.

The Modern Railway Wagon and the Details of Its Design. George Willans. A discussion of the present standard wagon specifications and their details, and high-capacity stock and future requirements. Ill. 1600 w. Prac Engr—Jan. 29, 1904. Serial. 1st part. No. 60700 A.

20-Ton Private Owners' Wagons. Official drawings and specification which are to regulate the construction of this class of rolling stock in England. 2500 w. Bul Int Ry Cong—Jan., 1904.—No. 60645 E.

Vanderbilt Steel Frame Tank Car. Drawings, photograph and detailed description. 6000 w. R R Gaz—Feb. 19, 1904. No. 61035.

Dynagraphs.

A Study of the Secondary Motions of Moving Cars (Etude des Mouvements sur les véhicules en Marche). M. Sabouret. A description of various recording instruments used for showing the lateral and other irregular motions of railway cars as used on the Western Railway of France. 6000 w. Rev Gen des Chem de Fer—Feb., 1904. No. 60952 H.

Electric Traction.

See Street and Electric Railways.

Locomotive Action.

The Destructive Action of Locomotive Engines (Die Störenden Bewegungen der Dampflokomotive). Herman Diepen. A mathematical investigation of the injurious inertia action of the moving parts of locomotives, including vibration, hammer-blow, etc. 6000 w. Glasers Annalen—Feb. 1, 1904. No. 60926 D.

Locomotives.

Asiatic Locomotives Constructed in Germany. Frank C. Perkins. Illustrations of two types, with brief notes. 300 w. Sci Am Sup—Feb. 20, 1904. No. 61053.

Blows and Pounds in Simple Locomotives. Discusses the causes, effects and remedies for these annoyances. 800 w. Loc Engng—Feb., 1904. No. 60583 C.

British Locomotive Work in 1903. Chas. Rous-Marten. A review of the principal characteristics of the work performed. 2500 w. Engr, Lond—Jan. 22, 1904. Serial. 1st part. No. 60619 A.

Centenary of the Locomotive Engine. W. B. Paley. Reviews the work of Richard Trevithick. 2500 w. R R Gaz—Feb. 12, 1904. No. 60794.

Compound Goods Locomotive, Saxony State Railways. Illustrated description of an engine of large power using superheated steam, and having features of in-

terest. 2000 w. Engr, Lond—Jan. 22, 1904. No. 60620 A.

Four-Cylinder Balanced Compound Locomotives. A. von Borries. States the advantages of the writer's system, comparing with the de Glehn system. Ill. 1500 w. Engr, Lond—Jan. 29, 1904. No. 60718 A.

Locomotives for the Cape Government Railways. H. W. Hanbury. Full illustrated detailed description of two new six-wheel coupled engines, adapted for the use of superheated steam, on the Schmidt system. 3000 w. Engng—Jan. 22, 1904. No. 60615 A.

New York Central Pacific Type Locomotives. Illustrated detailed description of engines designed to handle fast trains. 1500 w. Ry & Engng Rev—Feb. 13, 1904. No. 60865.

Simple Consolidation Locomotive for N. Y. C. & H. R. R. R. Illustrations and general dimensions of engines designed for heavy, fast freight work. 700 w. Ry & Engng Rev—Jan. 30, 1904. No. 60578.

Switching Locomotive for the Pennsylvania Lines. Illustrated description of a 6-wheel switcher, Class B-6. 400 w. Ry Age—Jan. 29, 1904. No. 60543.

Ten-Wheel Express Locomotive for India, Built in Scotland. Illustration and leading dimensions. 400 w. Ry Age—Feb. 12, 1904. No. 60864.

The French Locomotive of the Great Western Railway. Charles Rous-Marten. An account of the first business trip of engine No. 102, La France. Not a trial trip. 1000 w. Engr, Lond—Feb. 5, 1904. No. 60829 A.

What Should be the Maximum Economical Load for a Locomotive? Charles T. Noyes. Considers the requirements of locomotive service. General discussion. 8000 w. Pro Pacific C Ry Club—Jan. 16, 1904. No. 60532 C.

Locomotive Tests.

Comparative Tests of Locomotives Using Saturated and Superheated Steam. Abstract of an article by Herr Strahl in *Zeitschrift des Vereins Deutscher Ingenieure*. Describes the experiments and gives results. Ill. 3300 w. R R Gaz—Feb. 19, 1904. No. 61036.

Indicator Tests of a Large Tandem Compound. Cards and data obtained from one of the tandem consolidation engines of the Santa Fe, showing the net tractive effort. 500 w. Am Engr & R R Jour—Feb., 1904. No. 60587 C.

Working Indicator Trials (Essais Effectués en Service Courant et à l'Aide d'Indicateurs de Pression). MM. Marchis and Ménétrier. Report of tests of 2-cylinder compound locomotive, with numerous indicator diagrams. 1000 w. 4 plates. Rev Gen des Chemins de Fer—Feb., 1904. No. 60953 H.

Railway Vehicles.

Automobile Railway Vehicles (Les Voitures Automotrices des Chemins de Fer). L. Turgan. Illustrating and describing various forms of self-propelled cars for special uses on railways, including both steam and petrol as motive power. 6000 w. 1 plate. Mem Soc Ing Civ de France—Nov., 1903. No. 60933 G.

The New Steam Automobile Car of the Northern Railway of France (La Nouvelle Voiture Automobile à Vapeur du Chemin der Fer du Nord). MM. Sartiaux and Koechlin. Illustrated description of steam motor car for railway service, with details of water-tube boiler, and running gear. 3500 w. 3 plates. Rev Gen des Chemins de Fer—Jan., 1904. No. 60951 H.

Relief Valve.

The Relief Valve as a Detriment to the Successful Operation of a Locomotive. G. W. Mudd. Gives the writer's theories in regard to this question. General discussion. 3000 w. St. Louis Ry Club—Jan. 8, 1904. No. 60737.

Repairs.

A Shop Schedule for Locomotive Repairs. Presents the schedule for locomotive repairs at the Chicago shops of the Chicago & Northwestern. 700 w. Am Engr & R R Jour—Feb., 1904. No. 60588 C.

Stays.

Stays of Adjustable Length for Locomotives of the Danish State Railways. O. Busse. Translated from *Organ für die Fortschritte des Eisenbahnwesens*. Illustrates and describes a new system applied on these locomotives which allows the tube plate to expand freely. 700 w. Bul Int Ry Cong—Jan., 1904. No. 60641 E.

Trucks.

Side-Bearing Trucks. W. J. Knox. Illustrates a truck which aims to combine and improve the best features of both side-bearing and center-bearing trucks, and compares it with the regular center-bearing truck. 2000 w. Ry Age—Jan. 29, 1904. No. 60545.

NEW PROJECTS.

Europe-Pacific.

New Railway Between Europe and the Pacific. Dr. Convall Spatzier. Summary of an article in the Austrian magazine, *Die Reform*. Favors the construction of a new line to compete with the Russian line, showing the advantages. Map. 2000 w. Bul Int Ry Cong—Jan., 1904. No. 60643 E.

Improvements.

Big Four Revision Between Cincinnati and Sunman. Describes improvements made with a view to reducing the grades

We supply copies of these articles. See page 157.

and rectifying the alignment between Lawrenceburg Junction and Sunman. Ill. 1400 w. Ry Age—Jan. 29, 1904. No. 60544.

PERMANENT WAY AND BUILDINGS.

Coal Chutes.

Coal Chutes for Locomotives. Illustrates and describes chutes used on the Baltimore & Ohio Railroad which are made to measure the coal delivered as accurately as it can be measured by volume. 1000 w. Am Engr & R R Jour—Feb., 1904. No. 60589 C.

Construction.

Construction, Equipment, Maintenance and Management of a Railroad. F. P. Roesch. Briefly considers these subjects. 4000 w. Pro Pacific C Ry Club—Jan. 16, 1904. No. 60754 C.

Construction Work of the Southern Indiana Railway. Illustrated description of construction work in the coal districts of Sullivan and Greene counties. 1800 w. Eng News—Feb. 25, 1904. No. 61084.

Notes on Railway Construction from the Resident Engineer's Standpoint. F. C. French. Slightly condensed paper read at the meeting of the Iowa Engng Soc. Calls attention to points of difference in the practice of a number of roads, in the hope of securing uniformity and of giving information to young engineers. 8000 w. Eng News—Feb. 4, 1904. No. 60674.

Flood Repairs.

Flood Repairs to the Lehigh & Susquehanna Division of the Central Railroad of New Jersey. M. A. Zook. Illustrations with description of repairs to roadbed and bridges. 1000 w. Eng News—Feb. 4, 1904. No. 60673.

Grade Crossings.

Grade Crossing Protection Between Steam and Electric Railways. Illustrates and describes the means of protection adopted by the Public Service Corporation of New Jersey. 800 w. Ry Age—Feb. 5, 1904. No. 60684.

Rails.

Researches on the Bending of Rails. A. Flamache. A study of this problem both under static and rolling loads. Mathematical. 8000 w. Bul Int Ry Cong—Jan., 1904. No. 60640 E.

Shops.

New Shops of the Chicago, Rock Island & Pacific Ry. at East Moline, Ill. An illustrated detailed description of a very interesting new plant. 4300 w. Eng News—Feb. 11, 1904. No. 60792.

Signalling.

Automatic Block Signals and Interlocking on the New York & Long Branch Railroad. Illustrates and describes a remarkable installation covering 37½ miles, and costing $175,000. 1000 w. Ry Age—Feb. 19, 1904. No. 61013.

Automatic Railway Signalling. Briefly reviews the power and automatic signalling systems, the methods of working, &c., and discusses the question of the normal position of signals. 3000 w. Engr., Lond—Feb. 12, 1904. Serial. 1st part. No. 61003 A.

Modern Power Signalling. Illustrated description of the electro-pneumatic signalling system, indicating the main principles. 1800 w. Engng Times—Feb., 1904. No. 61060 B.

Performance of Automatic Signals in Cold Weather. H. S. Balliet. A discussion of the more important failures during the severe weather of this winter. 1200 w. R R Gaz—Feb. 26, 1904. No. 61085.

Uneconomical Use of Block Signals. Editorial suggested by the address of Mr. Hope before the Ry. Signal Assn. 1000 w. R R Gaz—Feb. 26, 1904. No. 61087.

Terminals.

An Important New Terminal-Yard-Lighting and Power Plant. Illustrates and describes an installation in process of construction at Weehawken, N. J., for the West Shore R. R. 1600 w. Am Engr & R R Jour—Feb., 1904. Serial. 1st part. No. 60585 C.

The Cost of Handling Locomotives at Terminals. Charles H. Fry. Gives figures showing what these costs average for different roads in different parts of the country. 2000 w. R R Gaz—Feb. 19, 1904. No. 61032.

Turn-Table.

An All Cast-Iron Turn-Table. James C. Bennett. An illustrated description of a turn-table for industrial tracks, designed to increase the efficiency and lessen cost. 900 w. Eng & Min Jour—Feb. 4, 1904. No. 60652.

Widening.

Widening the Gauge of the National Railroad of Mexico. J. L. Bothwell. An account of the interesting features of this work. 800 w. Eng Rec—Feb. 20, 1904. No. 61020.

TRAFFIC.

British Railroads.

Stability of Traffic on British Railroads. Reviews an article published in *The Statist* (London) on the relative stability of the traffic on British railroads compared with that of other countries. 1000 w. R R Gaz—Jan. 29, 1904. No. 60568.

Rates.

Why Live Stock Carrying Rates Are Too Low. W. W. Cotton. Considerations presented at the convention in Portland, Ore., showing the costliness and hazard in connection with this class of

traffic. 3500 w. Ry Age—Feb. 12, 1904. No. 60863.

MISCELLANY.

China.

The Railways of China. Arthur Judson Brown. An illustrated account of roads built and under construction, the difficulties met, and related matters of interest. 3500 w. Rev of Revs—Feb., 1904. No. 60528 C.

Economy.

Economy in Railroad Operations. W. B. Waggoner. Outlines the general situation and offers suggestions based on study and experience. General discussion. 12600 w. Pro W Ry Club—Jan. 19, 1904. No. 60804 C.

Franchise Values.

Railroad Franchise Values in Texas. W. H. Coverdale. Remarks on the methods of the Texas Commission in the matter of valuation. 1000 w. R R Gaz—Feb. 12, 1904. No. 60798.

Railway Inventions.

What the Inventor has Done for the Railway Worker. Arthur M. Waitt. Discussing improvements in permanent way, rolling stock, motive power, and details of railway operation. 3000 w. Engineering Magazine—March, 1904. No. 60989 B.

Valuation.

Methods Used by the Railroad Commission of Texas, Under the Stock and Bond Law, in Valuing Railroad Properties. R. A. Thompson. Report of this law and the railroads valued since its passage, describing the methods used. 5400 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60742 E.

STREET AND ELECTRIC RAILWAYS

Air Brakes.

Storage Air Brake System in St. Louis. Illustrates and describes the system adopted, considering the particulars and reasons for the choice of this type. 2500 w. St Ry Jour—Feb. 6, 1904. No. 60691 D.

Brooklyn.

Traffic Conditions on the Brooklyn Rapid Transit System. C. R. Barnes. Abstract of report of the electrical expert of the Railroad Commissioners of the State of New York. 3000 w. St Ry Jour—Feb. 20, 1904. No. 61018 C.

Bulgaria.

Electric Tramways of Sofia. Illustrated description of tramways operated by means of a high tension water power station with low tension steam power station for reserve. 1400 w. St Ry Rev—Feb. 20, 1904. No. 61078 C.

Construction.

Notes on the Construction of an Electric Road and Power-House at Morgantown, West Virginia. Walter Loring Webb. An illustrated description of the construction of a road where the conditions were in some respects unusual, the question of grade having much influence on the route. Discussion. 4700 w. Pro Engrs' Club of Phila—Jan., 1904. No. 60761 D.

Contact Rails.

Preliminary Work in Laying Out a Contact Rail System. William A. Del Mar. Deals with the practical problems with which a draughtsman has to contend when preparing to lay out a system of contact rails. 900 w. Am Elect'n—Feb., 1904. No. 60596.

Electric Traction.

Electric Power for Railways. B. S. Lanphear. Read before the Iowa Engng. Soc. A brief review of early electric railroading, and its progress. 1700 w. Elec Rev, N. Y.—Feb. 20, 1904. No. 61015.

The Future of Electric Traction on Main-Line Railways (Considerations sur l'Avenir de la Traction Electrique sur les Grandes Lignes de Chemins de Fer). R. Bonnin. A comparison of the results attained upon local and municipal railways with the requirements for main-line service. Two articles. 6000 w. Revue Technique—Jan 10, 25, 1904. No. 60909 each D.

Ilford.

Ilford Corporation Tramways. Illustrated description of a line forming a part of the suburban tramway system of London. 4000 w. Tram & Ry Wld—Feb. 11, 1904. No. 61074 B.

Interurban.

The Conneaut & Erie Interurban System. Illustrated detailed description of the line and equipment. 4000 w. St Ry Jour—Feb. 6, 1904. No. 60690 D.

Italy.

Main Line Electric Traction in Italy (Elektrische Vollbahnen in Italien). Pietro Lanino. A general description of the satisfactory operation of the lines in northern Italy. 4500 w. Elektrotech Zeitschr—Feb. 11, 1904. No. 60964 B.

"Key Route."

The San Francisco, Oakland & San Jose Railway—"The Key Route." Illustrated description of an electric railway having interesting features, and operating trains instead of single cars. 3500 w.

We supply copies of these articles. See page 157.

St Ry Jour—Feb. 13, 1904 Serial. 1st part. No. 60848 C.

London.

London's New Tube Railroad. C. H. Grinling. Information concerning the Great Northern & City Railway, recently completed. Ill. 1400 w. R R Gaz—Jan. 29, 1904. No. 60567.

The Electrification of the Metropolitan Railway. The first of a series of illustrated articles showing the progress that has been made in the electrical equipment of this road. 2000 w. Engr, Lond—Feb. 12, 1904. Serial. 1st part. No. 61002 A.

Los Angeles.

Los Angeles Traction and California Pacific Railway Companies. Samuel B. McLenegan. Brief illustrated description of this line. 2200 w. Jour of Elec, Power, & Gas—Jan., 1904. No. 60769 C.

The Los Angeles and Pacific Railway Companies. Illustrated description of the construction, equipment and engineering features. 6000 w. Jour of Elec, Power & Gas—Jan., 1904. No. 60768 C.

Measuring Car.

The Measuring Car of the Berlin Tramways (Messwagen der Grosser Berliner Strassenbahn). Emil Björkegren. A fully illustrated description of a trolley car carrying a switchboard and complete set of instruments for local testing. 2000 w. Elektrotech Zeitschr—Jan. 28, 1904. No. 60959 B.

Oregon.

The Oregon Water Power and Railway Company. George I. Brown. An illustrated article reviewing the history and describing the property of this company, which operates steel car, suburban, interurban, and heavy freight traffic. 4000 w. Jour of Elec, Power, & Gas—Jan., 1904. No. 60770 C.

Paris.

Electric Railway Construction in Paris. Francis Paul. Illustrates and describes the conduit system of the General Parisian Tramways Company. 4000 w. Am Elect'n—Feb., 1904. No. 60593.

Power Equipment.

Improvements in the Power Equipment of the Cleveland & Southwestern System. Illustrated description of one of the first steam turbine installations for electric railway work in the United States. 7500 w. St Ry Jour—Jan. 30, 1904. No. 60546 C.

Providence, R. I.

Manchester Street Power Station of the Rhode Island Company, Providence. Illustrated description of a plant of special interest because of the arrangements and details of the machinery and apparatus, and the fireproof construction of fine design. 2700 w. Eng Rec—Feb. 20, 1904. Serial. 1st part. No. 61023.

Railway Power Plant at Providence, R. I. Illustrates and describes a new station, having a capacity of 10,500 Kw. Both direct and alternating current is furnished. 4800 w. St Ry Jour—Feb. 20, 1904. No. 61017 C.

Rail Welding.

Electric Rail Welding on the Glasgow Tramway System. Benjamin Taylor. Illustrated description of the work as carried out by the Lorain Steel Company, of Lorain, Ohio. 2500 w. Engng Rev—Feb., 1904. No. 61065 B.

San Francisco.

The United Railroads of San Francisco. An illustrated account of these lines, their features of interest and equipment. 6000 w. Jour of Elec, Power & Gas—Jan., 1904. No. 60771 C.

Single-Phase.

Single-Phase Electric Traction (Traction Electrique avec Moteurs Monophasés). E. Dieudonné. A review of recent experiments in Europe and America. 2000 w. Revue Technique—Jan. 10, 1904. No. 60907 D.

Steel Cars.

Interborough Rapid Transit All-Steel Cars. Illustrated detailed description of an experimental car now in use on the Second Ave. line in New York, of a type proposed for the subway. 400 w. Ry Age—Feb. 19, 1904. No. 61012.

Steubenville, O.

The Railway System of the Steubenville Traction & Light Co. Illustrates and describes this company's system and power house which includes a gas-producing plant, an electric lighting plant, and an electric traction plant. 6500 w. St Ry Rev—Feb. 20, 1904. No. 61079 C.

Switzerland.

The Street Railway System of Schaffhausen, Switzerland. Illustrates and describes one of the most prominent Swiss installations. 1800 w. St Ry Jour—Feb. 13, 1904. No. 60849 C.

Third Rail.

The Third Rail System of the North Shore Railroad. George P. Low. Illustrated detailed description of an important electric railway line in California. 8500 w. Jour of Elec, Power & Gas—Jan., 1904. No. 60767 C.

Trucks.

Development of the Brill System of Trucks for Electric Motor Cars. William H. Heulings, Jr. An interesting illustrated account, with discussion. 4500 w. Pro Engrs' Club of Phila—Jan., 1904. No. 60759 D.

We supply copies of these articles. See page 157.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.

Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.

Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.

Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.

Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.

Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.

Machinery. *m.* New York.
Madrid Cientifico. *s-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.

Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.

Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.

Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.

Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.

Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.

Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.

Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.

Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.

Yacht. *w.* Paris.

Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Gas Engines.

The Gas Engine. A Treatise on the Internal-Combustion Engine Using Gas, Gasoline, Kerosene or other Hydrocarbon as Source of Energy. By Frederick Remsen Hutton, E. M., Ph. D. Size, 9 by 6 in.; pp. xviii, 483; figures, 243. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

In recent years the internal combustion engine has become of great commercial importance, and while it does not at present rival the steam engine in numbers or amount of energy developed, its future is most promising, and it may yet outdistance the older prime mover. Together with the constructive advance of the internal-combustion engine, there has grown up a body of literature concerning its various forms, both in the pages of engineering periodicals and in books, but there was still ample room for a treatise such as the present one, systematically covering the subject, especially the theoretical part. Prof. Hutton starts in with the consideration of the energy contained in fuels of various kinds, and methods for the liberation of this energy and its conversion into useful work. The cycles of heat engines are touched upon in one of the earlier chapters, but the complete discussion of this topic is postponed until a later section of the book, when the theoretical analysis of the gas engine is treated pretty exhaustively, and all the possible cycles of the internal-combustion engine are classified. On the practical side, the principal types of gas, gasoline, kerosene and alcohol motors are described, and there are chapters on the proportioning of mixtures, carburation, ignition, governing, cooling, the manipulation of internal-combustion engines, and their testing. In a chapter on internal-combustion engines with heating at constant pressure, the recent work of Dr. Charles E. Lucke is summarized, and his apparatus for the continuous combustion of explosive mixtures is described. There are also descriptions of the Brayton and other types of engine which have operated with constant-pressure heating, and the future of such engines, including the gas turbine, is indicated. A record of tests of explosive mixtures is given, and the book concludes with a historical summary and a bibliography.

Marine Engineering.

A Manual of Marine Engineering: Comprising the Design, Construction and Working of Marine Machinery. By A. E. Seaton. Fifteenth Edition. Size, 9 by 6½ in.; pp. xxiii, 707; fully illustrated with plates and figures in the text. Price $6 (21s.). London: Charles Griffin and Co., Ltd. New York: D. Van Nostrand Co.

No better proof of the progress which has been made in marine engineering in the last quarter century can be found than by comparing the present edition of Mr. Seaton's manual with its first issue in the early eighties. At that time, the triple-expansion engine had hardly advanced beyond the experimental stage, boiler pressures of 100 pounds to the square inch were thought excessive, and steel as a constructive material for both engines and hull was considered a luxury. To-day, quadruple-expansion engines with five cylinders, steam pressures of 300 pounds, and the almost universal use of steel are among the features of modern marine engineering which mark the great advance. It has required frequent editions of the present work to keep pace with the art it describes, and this latest issue has been thoroughly revised, enlarged and in part re-written to bring it up to modern standard practice. The very newest developments, such as the steam turbine and oil fuel, are only briefly described, but the reciprocating engine and the steam boiler and all their details and accessories are very fully treated. Among the special subjects discussed are water-tube boilers, including all the standard types; the balancing of marine engines; the resistance of ships and the power necessary to drive them at different speeds; the design and construction of propellers; pumps; sea cocks, valves, steam-steering gears and other auxiliary machinery; oil and lubricants; and the materials used by the marine engineer. The book is very fully illustrated with plates and figures in the text, there are many tables, an appendix contains Lloyd's and other rules for boilers and other apparatus, and an index completes a work which is of great value and interest, and whose popularity is well attested by the fact that it has passed through fifteen editions in little more than twenty years.

Valve Gears.

The Lay-Out of Corliss Valve Gears. By Sanford A. Moss, M. S., Ph. D. Reprinted from *The American Machinist* with Revisions and Additions. Size, 6 by 3¾ in.; pp. 108; plates 3, figures 8. Price, 50 cents. New York: D. Van Nostrand Company.

Although the Corliss valve gear in its various forms has had the widest application in practice, it has not been adequately treated from a theoretical point of view until the appearance of the present work, in which is given a complete discussion of the principles underlying the kinematic design, or "lay-out," and also explicit directions for making a lay-out on the drawing board. The methods employed are such as may be used with success by any one who has mastered the fundamental principles, in contradistinction to the ordinary rule-of-thumb directions, which give good results only in the hands of experienced designers. A clear description of the Corliss valve-gear mechanism and its operation forms an introduction to the theoretical part of the book, which is then developed in several chapters, with diagrams, in a way that will be of great interest and value to the student and the designer of Corliss engines.

Wireless Telegraphy.

Maver's Wireless Telegraphy: Theory and Practice. By William Maver, Jr. Size, 9 by 6 inches; pp. vi, 205; figures, 123. Price, $2. New York: Maver Publishing Co.

Those who are trying to keep pace with the advances in wireless telegraphy will welcome the present volume, which gives a very good account of the development of this new art and of its present state, and affords a secure starting point from which to follow its further progress. The author is a telegraph engineer of long standing, is also the author of the standard work, "American Telegraphy and Encyclopedia of the Telegraph," and has had considerable experience in the operation of wireless telegraph systems, so that he writes with a first-hand knowledge of his subject and an appreciation of the many practical points which are felt only by actual contact with them. After the introductory portion of the book, in which, among other things, the induction-telegraph systems of Phelps, Edison, Preece, etc., are described, the theory of Hertzian-wave telegraphy, on which the modern "wireless" systems are founded, is discussed. Then follow detailed accounts of the systems of Marconi, De Forest, Lodge-Muirhead, Slaby-Arco, Braun, Branly-Popp, Fessenden, Stone, Shoemaker and various other inventors. Signaling by ultra-violet light and light telephony are also described, and a chapter is devoted to theoretical and practical notes on wave detectors, interrupters, transformers, oscillators, the spark gap, condensers, and the antennae, or aerial wires. As wireless telegraphy has grown so rapidly, even while this book was being written, the most recent developments of some of the systems appear in different places from the descriptions of their fundamental features, but this is taken care of by cross references in the text and by a full index. The book is written in plain language, as free from abstruse technicalities as possible, and has many diagrams and other illustrations, so that it will be of interest to the general reader who wishes to keep in touch with this fascinating branch of electrical engineering, as well as of great value to the technical men who themselves are pushing this work so rapidly ahead.

BOOKS RECEIVED.

A Treatise on Friction and Lost Work in Machinery and Millwork. By Robert H. Thurston, M. A., LL. D., Dr. Eng'g. Seventh Edition. Price, $3. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Proceedings of the Society for the Promotion of Engineering Education. Vol. XI. Price, $2.50. New York: Engineering News Publishing Co.

American Meter Practice. By Lyman C. Reed. Price, $2. New York: McGraw Publishing Co.

Points for Buyers and Users of Tool Steel. By George W. Alling, M. E. Price, $2. New York: David Williams Company.

Free-Hand Lettering. By Victor T. Wilson, M. E. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Moderne Gesichtspunkte für den Entwurf Elektrischer Maschinen und Apparate. By Dr. F. Niethammer. Price, 8 marks ($2.50). Munich and Berlin: R. Oldenbourg.

Reflections on Heating and Ventilating Engineering. By Konrad Meier. New York: Konrad Meier, 27 East 22nd Street.

Facts About Peat, Peat Fuel and Peat Coke. By T. H. Leavitt. Price, postpaid, $1.10. Boston: Lee and Shepard.

Alternating Currents: Their Generation, Distribution and Utilization. By George T. Hanchett. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Machine Design. Part I. Instruction Paper prepared by Charles L. Griffin. Chicago: American School of Correspondence Instruction at Armour Institute of Technology.